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ENGINEERING CONSTRUCTION WEEKLY

# ENGINEERING NEWS-RECORD

APRIL 13, 1939

Crowding a rock-ballast slurry on the Pennsylvania R.R.

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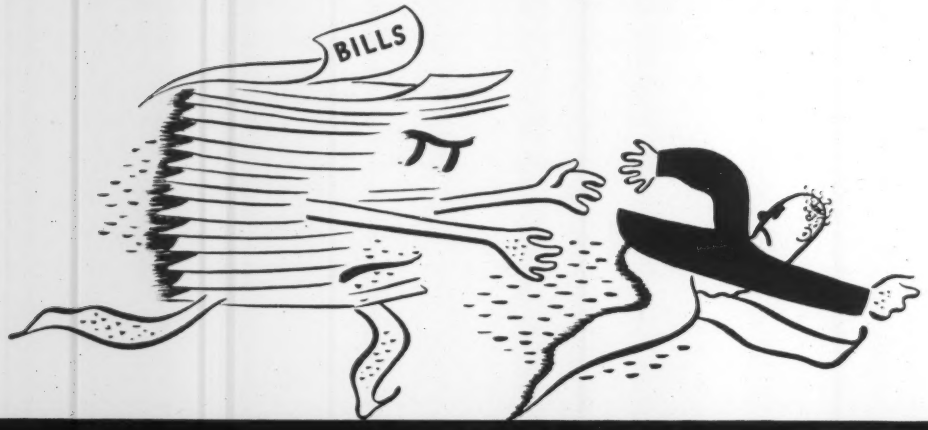


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# ENGINEERING NEWS-RECORD

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## THIS WEEK

● Typical of the versatility of subject matter in *ENR's* news-technical numbers is this week's list of contents. In addition to the regular departments there are sixteen articles covering fifteen subjects ranging from practical field surveying to design and construction.

● The lead article tells of the construction of a four-lane dual road over an old-three-lane artery leading into Indianapolis. Devices for speeding curb construction are described in considerable detail.

## THINGS TO COME

ROAD MAINTENANCE, least comprehended of all highway engineering activities, comes in for long neglected attention in a series of articles beginning in the issue of April 27. These articles are not a manual of maintenance practices; they tell the far greater story of maintenance in its public relations. Six articles will pictorialize road upkeep as: A Big Public Works Business; a Meticulous Housekeeping Task; a Precisely Audited Use of Tax Money; a Service to Recreation; a Fight Against Storm, and a Succor in Flood. Pictures tell a large part of the story.

CONSTRUCTION COSTS, 1939 EDITION, is on the press, and will be published as a part of the April 27 issue. Thus, the practice inaugurated last year of making these valuable estimating and bidding data available to every reader is again being followed. Previously, since 1927, Construction Costs had been a booklet sold separately.

This year, Construction Costs will contain more data on building costs than heretofore and in addition all of the established features, such as building and construction cost indexes, railway and public utility cost figures, prices of construction materials and labor rates, highway cost trends, compensation insurance rates and unit bid prices.

Technical articles and news will be presented as usual.

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# NEWS

Volume 122 APRIL 13, 1939 Number 15

## *City Held Liable For Unauthorized Work*

**Court says failure to authorize extra work does not justify non-payment**

In a decision offering an important exception to the usual rule that a contractor will not be paid for doing municipal work which has not been properly authorized, the Connecticut Superior Court last week held that the city of Danbury must pay a paving contractor for extra work even though no appropriation had been made for the work.

The firm of Leverty & Hurley was awarded a paving contract in 1936 for which the city had appropriated $5,000. It later became apparent that an additional $1,500 would be needed to carry out the work, and later yet it was decided to include construction of gutters and some other work in the paving job. The Danbury superintendent of public works ordered the contractor to carry out this extra work, and it was agreed that it would be paid for on a unit cost basis.

When the work was completed, the city paid the contractor $5,000 and refused further payment on the ground that the extra work had not been properly authorized and no funds had been appropriated for it. The contractor brought suit and, in awarding him $13,000, the court held that the city could not avoid just payment.

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## *Hamilton Bidders Must Name Subcontractor*

The city council of Hamilton, Ont., has decided to insert in all future city contracts a clause requiring bidders to name the subcontractors they propose to employ. The new regulation is intended to eliminate bid peddling.

*Wide World photo*

**BOMBS DAMAGE LONDON BRIDGE**

EXPLOSION of two time bombs late last month did some damage to the Hammersmith suspension bridge over the Thames River in London, England. As may be seen in the picture, part of the stiffening truss, and a main eyebar and one suspender rod were broken. One side of the bridge sagged about a foot below its normal level. Recent bombings in Britain have been attributed to the Irish Republican Army.

Hammersmith Bridge, farthest upstream of the London bridges, was built in 1827 and reconstructed in 1887.

## *Label Demanded On Drawings*

**Auto workers union orders members to insist on FAECT label on plans**

Workers in automobile plants will refuse to use drawings and plans prepared by designers who are not members of the CIO engineers union, the Federation of Architects, Engineers, Chemists and Technicians. A resolution to this effect was adopted at the recent convention of the CIO affiliated United Auto Workers Union.

The resolution pointed out that "the FAECT is the organization of the designing engineers in the auto field" and directed "that all our members who use drawings and blue prints in their line of work in auto plants and parts plants and tool and die shops demand the union label of the FAECT on all drawings and blueprints they use."

The Society of Designing Engineers, recently affiliated with the FAECT, forms the auto division of the engineers union.

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## *New York Planning Body Makes First Report*

The New York City Planning Commission, established early last year when a new charter went into effect for the city, has made its first annual report. The document indicates the lines along which it is working in carrying out the duty given it by the charter of drawing up a master plan for the development of the city.

Reduction of the traffic difficulties of the metropolis, the commission feels, will have to be achieved by reorganizing the city in a multitude of industrial and commercial centers around which desirable residential sections would be grouped, so that most people would be able to live close to their work. To accomplish this, it will be necessary to encourage rebuilding of the old residential areas in the center of the city and to encourage development of new industrial areas away from the center.

## Permissive License In Maryland

**Examination for engineering license may be taken immediately on graduation from college**

A license law providing for registration of professional engineers and land surveyors but not requiring registration has been passed by the Maryland legislature. The terms "licensed professional engineer" and "licensed land surveyor" are restricted to those qualifying under the act, but the law specifically states that it shall not be construed to require employment of licensed personnel "in any project of any kind whatsoever or in any position involving professional engineering or land surveying or both."

Unusual also is the provision that when examinations are required for a license, the examination on engineering fundamentals may be taken before the applicant has accumulated the required field experience, thus permitting young engineers to obtain what amounts to a sub-professional standing when just out of school. Examination credit will be good for ten years, during which time a license may be granted without re-examination whenever the necessary experience is acquired.

The Maryland bill in effect gives perpetual status to registered engineers by omitting any provision for license renewals. An unusually flexible reciprocity clause authorizes the state board to negotiate reciprocity agreements with other states, including those with differing standards. In most other respects the bill follows the model license law.

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## New Contract Let On New York Building

Contract to complete the foundations of the Criminal Courts Building in New York City has been awarded to Spencer White & Prentis of New York on a basis of cost plus a fee of $150,000. The amount involved is expected to reach about $2,020,000, including repairs to adjacent buildings and streets.

A previous $1,735,000 contract for construction of the foundation, held by L. P. O'Connor & Co., was declared in default early last month (*ENR*, Mar. 2, 1939, p. 73), after the contractor stopped work, asserting that large boulders he encountered had not been shown by the city's borings. The contract called for completion of the caisson and pile foundations Feb. 14, and carried a penalty clause of $2,500 a day. Only about a quarter of the foundation work has been completed.

It was first planned, according to New York Public Works Commissioner I. V. A. Huie to award the new contract to H. J. Duetschbein Co. and the Peter F. Connolly Co. But Duetschbein became ill, and Spencer White & Prentis agreed to take over the contract on the same terms. Six months is allotted under the new contract for completion of the foundation work.

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## Arkansas Subcontractors Must Be Licensed

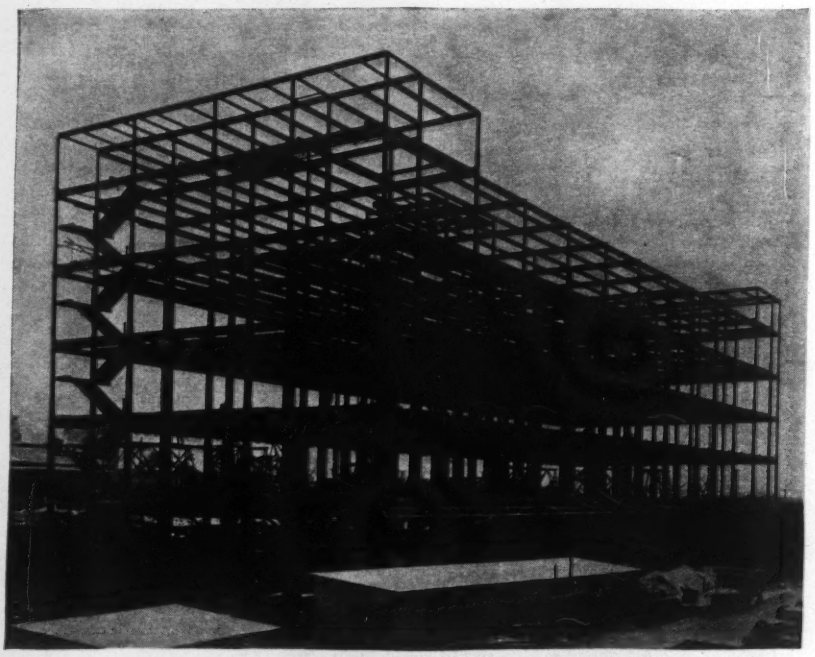
Subcontractors in Arkansas who hold contracts worth more than $10,000 are subject to the state licensing act, State Attorney General Jack Holt ruled recently.

Holt said that even though a contract be placed through a second party who is a licensed contractor, the subcontractor is subject to the Arkansas law, which requires a license for all contractors undertaking jobs costing more than $10,000.

## Pennsylvanians Indicted For Highway Fraud

Alleged waste of about $500,000 of public funds in the operations of the Pennsylvania highway department in Luzerne County led last week to the indictment of 76 men, mostly former executives and employees of the highway department, by a special grand jury which has been investigating conditions in Luzerne County. Roy Brownmiller, former secretary of highways, John Conlon, Jr., superintendent of highways in Luzerne County, and William J. Carroll, district engineer for the highway department, were among those named by the grand jury; most of the other men indicted are assistant highway superintendents and foremen. Brownmiller is already under indictment by a Dauphin County grand jury in connection with the Luzerne County operations.

Practices alleged consist largely of payroll padding and use of state forces for private work.



**TOBACCO PLANT INVOLVES SPECIAL DESIGN**

UNUSUAL HEIGHT between floors, 17.5 ft. throughout, and design for a floor load of 200 lb. per sq.ft., is a special feature of this new building for the manufacture of Bull Durham tobacco so that it may be converted, if desired, into a cigarette factory or a storage warehouse. Double windows throughout to prevent condensation arising from the air conditioning of the building is another unusual feature.

This five-story building with its half-acre floor area is expected to be completed in June. Its construction involves the use of 1,500 tons of structural steel erected on reinforced concrete footings poured on rock. Floors are of 7-in. reinforced concrete, later to be covered with maple flooring. Exterior walls will be brick.

Work on the building was begun last November. Francisco & Jacobus of New York are the architects and engineers on the project for the American Tobacco Co., the owner. The general contract, amounting to $500,000, is held by George W. Kane of Durham, North Carolina.

## Arizona Reorganizes Road Maintenance

**Responsibility for maintenance transferred to sixteen resident engineers instead of 42 foremen**

The maintenance division of the Arizona highway department has been completely reorganized by the new state highway engineer, W. R. Hutchins. The state is now divided into four districts, each under the supervision of a district engineer with headquarters in Phoenix. Each of the districts is divided into four sub-districts, with a resident engineer in charge of maintenance and construction in each subdistrict. This work was previously carried out by 42 maintenance foremen. Resident engineers have their headquarters at centrally located places in the sub-districts.

Appointed as district engineers are Joe DeArozena, F. N. Grant, R. C. Perkins, and J. B. Van Horn. All four are highway department veterans.

Harry Duberstein, who assisted Hutchins in the reorganization, has been transferred from the post of maintenance engineer, which he had held for many years, to that of right-of-way agent.

It is estimated that the new organization of road maintenance work will result in an annual saving of $300,000.

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## Building Material Prices Pegged in Chile

Unprecedented demands for building materials in Chile as the result of destruction in the earthquake of last January have made it necessary for the government to fix the price of materials, the U. S. Department of Commerce reports. A committee composed of representatives of the building materials industry and two government representatives has been set up to regulate the prices.

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## Officials Indicted Again On N.Y. Land Fill

Already under indictment in Richmond County, N. Y., New York City Commissioner of Sanitation William F. Carey has been indicted again in Queens County on charges that the land fills he is operating there for disposal of city rubbish and garbage constitute a public nuisance. Indicted with Carey was City Health Commissioner Dr. John L. Rice.

Attacking the operation of the five land fills in Queens County, the indictment charges the commissioner with failure to dispose of city refuse "in a reasonably safe and proper manner," with maintaining objectionable conditions at the land fill, and with violating the sanitary code.

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## Expired Water Franchise Held Still in Force

The City of Springfield, Mo., may not forbid the Springfield City Water Co. to use the city's streets, even though the water company's franchise expired in 1902. The Missouri Supreme Court so held Apr. 4 in refusing to order the water company to stop using the streets.

Official acts by the city since 1902 acquiescing in operations of the company had, the court held, "expressly construed" the original franchise ordinance adopted in 1882, as "granting a franchise in perpetuity." The only way the city could terminate the franchise would be to buy the company's property.

The ouster proceedings were filed by the city in December, 1936, after a controversy over water rates.

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## Distillers Agree to Pay For Use of Sewer

A group of distilleries outside the city limits of Louisville, Ky., have agreed to pay the city 43 cents per $100 of their assessed valuation for the right to dispose of their waste products through a city-built outfall sewer. The distillers agreed to regulate the acids thrown into the sewer according to specifications which are to be drawn up by a committee of city officers and others.

City officials assert that past dumping of waste into the sewer by these distilleries has caused it to show signs of wear.

The committee which is to draw up the waste specifications consists of city engineer James B. Wilson, director of research C. C. Webb, city chemist Jack Lassen, assistant director of law Luther Roberts, Woolsey Kay, engineer for the Commission of Sewerage, and E. J. Wechter, superintendent of the Louisville Cement Co.

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## Sun Valley Chosen For Bituminous Conference

It has been decided to hold the 1939 Montana National Bituminous Conference at Sun Valley, Idaho, Sept. 11-13. Don A. McKinnon, chief engineer of the Montana highway department, will be general chairman, while D. L. Cheney, bituminous engineer for the department, will be vice-chairman in charge of arrangements.

## Niagara Sewage Plant Passes Final Test

**Consultant for city finds plant more than meets specifications in 52-day test**

Acceptance by the City of Niagara Falls, N. Y. of its new sewage treatment plant has been recommended to the city council by Willem Rudolfs, sanitary consultant to the city. Rudolfs recently completed a 52-day performance test on the plant.

The plant, which is unique in its method of treatment in that it employs coke-mat filters superimposed on fine screens (*ENR*, Aug. 18, 1938, p. 197), was tested in accordance with specifications laid down by the city when the work was begun in May, 1936. The New York state department of health has announced that the plant meets its requirements for sewage treatment in the Niagara River at that point.

Rudolfs' report states that with a flow of 10 m.g.d. passing over each screen (20 per cent more than the expected load) the reduction in per cent of solids amounts to 26 per cent, while total settlable solids removal amounts to 37 per cent. About 73 per cent of the coke used for the mat filter is reclaimed; the coke actually used amounts to 233 lb. per million gallons of sewage treated.

Power consumption for the screens was found to be 3.8 kw.h. per m.g.; for sludge incineration, the power requirement was 3.7 kw.h., and oil use was 14 gal. per ton of wet sludge.

The incinerators are being operated without dewatering of the sludge. Centrifugal dewatering machines originally installed in the plant were removed when they failed to meet the specifications (*ENR*, Aug. 18, 1938, p. 188), and it was then found that the incinerators could handle the wet sludge satisfactorily.

George L. Watson was consulting engineer on the Niagara Falls plant, while A. Canuso & Sons were contractors. L. G. Rice, who is now plant superintendent, was resident engineer on the job.

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## Night Speed Limited In Kansas City

Speed of motor vehicles at night has been limited to 25 miles per hour in Kansas City, Mo., by an ordinance of the city council. A trial ordinance requiring this speed limit from half an hour after sunset to half an hour before sunrise is credited with reducing automobile accident deaths during the first three months of the year from 22 in 1938 to 9 in 1939.

## Contractor Is Held To Protested Price

**Court refuses extra pay on road contract — No extra time allowed for extra work**

An agreement signed by a contractor's superintendent to perform certain extra work at a stipulated unit price is binding on the contractor even though the agreement was signed under verbal protest, the Wyoming state district court at Cheyenne held Mar. 29. On another question arising out of the same case, it was held that it is for the court to decide how much extension of time should reasonably be allowed on the contract in consideration of extra work done, even though a specific time allowance was made in a supplementary agreement.

The Omaha Steel Works built a bridge for the Wyoming highway department over the Tongue River near Sheridan. During the course of the work, the state decided that the pier footings must go deeper than originally planned and a supplementary agreement was drawn up and signed by the contractor's superintendent on the job. The agreement set certain unit prices for this extra work. An agreement was also made and signed under which the contractor was to have 24 days extension of time to do the extra work.

### *Costs exceeds price*

The contractor subsequently brought suit, charging that the agreement on unit prices had been signed under verbal protest and that the extra work had actually cost $2,700 more than was paid under the contract. The contractor also charged that, in spite of the agreement that his time be extended, the state had deducted $25 a day for the full time by which he exceeded the original contract period.

The court held that the unit prices set up in the supplemental agreement were binding, even though the agreement was signed under protest.

### *Time extension*

As regards the penalty for delay, the court said that where the original plans are changed during the progress of the work, even though an agreement exists between the state and the contractor stipulating the time extension allowed for the changes, the total amount of penalty finally assessed against the contractor must be decided by the court on the basis of evidence submitted as to the fairness of the time extension allowed. In this case the court held that the state was justified in deducting the full penalty.

## Road Bid Held Invalid Due to Bidder's Error

A bid on highway work which was $50,000 too low because of an error on the part of the bidder was held invalid by the Supreme Court of Albany County, N. Y., Mar. 30, and the New York State highway department was ordered to return a deposit check of $44,000 to the bidder, the Callanan Road Improvement Co. of South Bethlehem, N. Y. The Callanan company had made the low bid of $599,000 on a highway project on which bids were opened Dec. 20. Subsequently the company notified the highway department that it had made an error in its bid, omitting several items which brought the total more than $50,000 below the intended figure. The Callanan company's bid, as submitted, was $140,000 below the engineer's estimate and $87,000 below that of the next bidder.

The department refused to return the check and proceeded with formal award of the contract. The contractor then instituted suit to secure return of the check and prevent the award.

The final court order held that because of the error the bid was invalid and of no effect.

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## Grand River Authority Is Reorganized

Reorganization of the Grand River Dam Authority has been effected through passage by the Oklahoma legislature of a bill reducing the membership of the authority from nine members to five. All of the members of the reorganized authority are to be appointed by the governor, whereas previously the members were appointed jointly by the governor, the labor commissioner, and the attorney-general.

Work on the Grand River Dam has been delayed by failure of the authority to acquire all the necessary rights-of-way and also by the fact that PWA has not yet purchased $11,000,000 of authority bonds with which 55 per cent of the cost of the project was to have been met; it is understood that doubts as to the legal status of the authority have held up the bond purchase.

*Wide World Photo*

**STATION LAYOUT FOR CHICAGO SUBWAY**

THE LAYOUT planned for the mezzanine level of the stations in the new Chicago subway is shown by this model. Passengers coming down from the street will descend from this level to the track level by escalators in some stations and by means of stairways at others.

The central passage between the cashier's cages will provide a free underpass by which pedestrians may cross from one side of the street to the other, while newsstands and other concessions will be housed in the spaces shown at the four corners. The mezzanine level will be about 60 ft. wide and 100 ft. long. Stations will be located in the middle of the block rather than at intersections.

Pouring of concrete for the actual subway tunnel began early last month. Although construction began Dec. 19, time had been spent sinking a construction shaft and approach tunnels before starting work on the subway tunnel itself.

## Bids Are Asked On Shasta Cement

**Treasury wants 5,800,000 barrels of low-heat cement for California project**

Bids will be opened May 1 by the procurement division of the Treasury Department on 5,800,000 barrels of low-heat portland cement to be used in the construction of the Shasta Dam of the Central Valley project in California. Cement is to be furnished in bulk, f.o.b. point of production or storage.

Three alternative bidding schedules are provided, and bids will be considered on less than the full requirements on whichever schedule adopted.

Under Schedule 1, bids would be taken only on requirements for the calendar year 1940. This would involve a total of 1,400,000 barrels to be delivered at a maximum rate of 195,000 barrels per month.

Schedule 2 contemplates contracts for the full amount necessary to complete the dam—5,800,000 barrels at a maximum rate of 290,000 barrels per month during the years 1940-1944, inclusive.

Schedule 3 would divide the cement into two parts, 3,100,000 barrels to be delivered at a uniform rate of 100,000 barrels per month during the full construction period, and a second part covering the variable needs. To meet the variable needs, bids will be considered either for 2,700,000 barrels, covering the full construction period, to be delivered at a rate not greater than 190,000 barrels per month; or bids will be accepted covering the calendar year 1940 only for 575,000 barrels to be delivered at a rate not greater than 95,000 barrels per month.

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## 280,000 Miles of Road Worked on By WPA

In the three years from the start of its program in July, 1935, to July, 1938, the WPA built or repaired 280,000 miles of highways, roads and streets, building 29,100 new bridges and repairing 23,500 others, Col. F. C. Harrington, WPA administrator, reported last week. About 30,500 miles of the roads worked on were within cities and villages, and 23,600 miles were paved roads. The bulk of the work was in rural areas on stabilization and draining of unpaved roads. About 45 per cent of WPA workers have been engaged on highway work.

During the same period WPA built 17,600 new public buildings and repaired 46,300 others; laid 6,100 miles of water mains and 8,900 miles of storm and sanitary sewers; built 4,500 new athletic fields, parks and playgrounds, and improved 10,700; and built 8,700 miles of new ditches for mosquito control and improved 5,000 miles of ditches; 26,700 dams were built for conservation purposes and 4,100 for storage.

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## New York Acts to Prevent Federal Power Projects

New York State took action to prevent federal development of power projects in the state last week when the legislature passed and sent to the governor a bill authorizing the federal government to acquire land for federal flood control projects but permitting acquisition of land only "during the time that the United States shall be or remain the owner thereof and shall use such property for flood control purposes."

Since the passage of the 1938 flood control act, under which the federal government pays all the costs and assumes full operation of its flood control projects, several states have attempted to limit the flood control operations of the government. Attempts by Vermont to limit the authority of the federal government over its projects are holding up an $11,000,000 New England flood control project; the governor of Oklahoma is vigorously opposing federal plans for the Dennison River Dam on the Red River; and Pennsylvania has liquidated most of the flood control studies it was making in cooperation with the federal government and expressed a desire to clarify its position in relation to federal flood control.

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## Third Pumping Plant Tested On Colorado Aqueduct

Colorado River Aqueduct water moved 110 miles towards the Southern California coastal plain early this month when tests began on the Iron Mountain pumping plant, 220 miles east of Los Angeles. The Iron Mountain plant is the third of the five pumping plants which will lift water a total height of 1,617 ft. in the course of its journey from the reservoir behind Parker Dam in the Colorado River to Los Angeles. The Iron Mountain plant has a lift of 144 ft.; from the top of the lift water flows through 40 miles of tunnel, conduits, and canals to the Eagle Mountain plant, 110 miles west of the Colorado River. Testing of the Eagle Mountain plant will start soon.

At the present time the entire aqueduct system is about 95 per cent complete. It is expected that first water from the Colorado River will be delivered to the Coast in the fall of 1939.

## Wider Upstream Slope Started at Fort Peck

**Army engineers begin to apply lessons gained from slide in the upstream face last fall**

Reconstruction of the upstream face of Fort Peck Dam, which was involved in the slide of last September, has been started in accordance with the recommendations of the board of consulting engineers which has been studying the slide. Two dredges began last month to pump fill into the additional upstream berm which was recommended by the board in order to flatten the average upstream slope and provide additional stability. About 900,000 cu. yd. of fill has already been placed, and it is hoped to complete the work of adding 12,500,000 yd. this year.

In the slide area itself a steel sheet-pile cutoff wall is being placed to connect the undisturbed core of the original dam with the rolled core of the reconstructed section. About 107,000 sq.ft. of this piling is now in place.

In all, about 16,000,000 cu.yd. of dredged fill will lie upstream from the original design section which was being followed at the time of the slide; this figure includes the 5,250,000 cu.yd. which moved in the slide and which is now upstream from the original design section. Placing this material will result in construction of a berm about 110 ft. high along the upstream side of the main dam throughout its length. Slopes of the berm vary from 1 on 7 to 1 on 50.

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## Company to Standardize Precast Concrete Shapes

A program for nation-wide distribution of precast concrete in standardized shapes for building work has been announced by the newly organized Cemenstone Corp. of Pittsburgh. Chairman of the board of Cemenstone is William P. Witherow, president of the Blaw-Knox Co.

Cemenstone will not itself manufacture precast concrete but will supply to qualified licensees throughout the country equipment for its patented precasting method. The Cemenstone method involves vibration of molds, curing at 160 deg. F. and provision for mass production.

It is planned to produce a line of shapes providing everything necessary for outer and inner walls, floors, and roofs of buildings. Among the products planned are blocks for wall construction, channel shape slabs for floors and roofs, concrete planks, joists, brick, insulating tile, and veneering.

# OBITUARY

SIR HENRY JAPP, chief engineer of the London, England, firm of John Mowlem Ltd., died in London, Apr. 9, at the age of 69. Japp was managing engineer on the construction of the Pennsylvania R.R. tunnels under the East River in New York City.

JOSEPH E. CRAIG, 57, Miami, Fla. consulting engineer, died there Apr. 4. Craig received a degree in mechanical and electrical engineering from Mississippi Agricultural and Mechanical College and a degree in civil engineering from Cornell University in 1903. Before entering private practice, Craig was active for many years in municipal and waterworks engineering in Florida.

G. LEON WALDRON, superintendent of the Hamilton, N. Y. board of water, light and sewer commissioners, who had been in the service of the city for about 39 years, died Apr. 4.

GEORGE L. WILSON, 84, engineer maintenance of way for the Twin City Rapid Transit Co., died in Minneapolis Apr. 1. Wilson had been with the street railway company for 36 years and was supervising engineer during construction of the Selby Ave. Tunnel in St. Paul during 1906 and 1907. Earlier he was assistant city engineer for the City of St. Paul. He was a graduate of the Yale Sheffield Scientific School.

GEORGE MORGAN, retired New York City builder, died last week in New York at the age of 78. Morgan was involved in the construction of the New York City Municipal Building and the original Equitable Life and New York Life Insurance buildings.

J. WILLIS FLICKINGER, head of the New York City contracting firm of Storey & Flickinger and connected with that firm for 40 years, died at Chambersburg, Pa., Apr. 7.

FREDERICK J. DIETERICH, supervising engineer and secretary prior to his retirement sixteen years ago of the United Engineering & Contracting Co. of New York City, died at East Orange, N. J. Apr. 6 aged 74. He was field executive in the construction of the Pennsylvania R.R. tunnel under Manhattan and on the approaches to the Williamsburg Bridge and was also involved in construction of part of the I.R.T. subway system in New York.

CLARENCE C. RICHARDS, civil engineer in the storm drainage division of the Los Angeles city engineer's office, died there Apr. 6. Before entering the city engineer's office fourteen years ago, Richards was connected with the Minnesota state highway department.

CARL W. SCHUBERT, Seattle construction engineer, died there Apr. 6, aged 60.

JOHN D. MYTON, United States engineer at Albany for the War Department, died Apr. 4 in Albany at the age of 57. Myton, a graduate of Rensselaer Polytechnic Institute in 1905, spent several years in railroad work in Pennsylvania and in 1911 joined the staff of the U. S. Army Engineers. He was assigned to the Albany office in 1912, becoming senior engineer in 1916, and assistant in charge in 1917.

J. S. CARPENTER, Des Moines contractor, died there Apr. 6 at the age of 68. Active in Iowa construction for 35 years, Carpenter was for many years president of the Iowa Bridge Co., last year forming the J. S. Carpenter Construction Co. He studied engineering at the University of Iowa.

HENRY J. WILKINS, for fifteen years a civil engineer with the New York Central Railroad, died in Pelham Manor, N. Y., Apr. 3 at the age of 39. Wilkins was a graduate of Manhattan College.

GEORGE A. MCKNIGHT, civil engineer of Fredericton, N. B., died there recently. He was a member of the engineering staff of the New Brunswick government and previously had been right-of-way engineer for the New Brunswick Electric Power Commission. He was for several years city engineer of Fredericton.

# CIVIL SERVICE EXAMINATIONS

NEW YORK: Assistant engineer, grade 4, board of water supply; $3,120; civil, sanitary, or mining degree, license, 5 years experience; apply before Apr. 17 to Municipal Civil Service Commission, Room 1400, Municipal Building, Manhattan.

LONG BEACH, CALIF.: Engineering draftsman; $152–$188; age 25–45; high school, one year's experience; apply before Apr. 15 to Civil Service Board, Room 608, City Hall.

TOLEDO: Supervising construction engineer; $350–$400; minimum age, 37; degree, license, 15 years experience.

Division engineer; $375–$350; minimum age 35; degree, license, 10 years experience.

Assistant division engineer; $225–$275; minimum age 30; degree, license, 7 years experience.

Engineer; $175–$250; minimum age 30; degree, license, 7 years experience.

Apply for above positions before May 1 to Civil Service Commission, 320 Safety Building.

*Engineering News-Record lists only examinations on which there are no residence requirements.*

*Examinations offered by federal, state, municipal, and county governments and by special districts are listed. Civil service commissions whose examinations are not shown are invited to send notices to Engineering News-Record.*

*Wide World Photo*

**ITALIAN GEYSERS GENERATE POWER**

STEAM for this new turbine plant and transmitter station at Larderello, Italy, comes from steam wells sunk in a volcanically active area.

The large structures at the left are condensation towers in which steam from the wells is condensed into water, purified and turned again into steam by the heat of the natural steam coming from the earth at 220 deg. F.

# LABOR NOTES

OERATIONS at the Green Mountain dam of the Colorado-Big Thompson project were tied up for a week last month by a strike called in an effort to obtain a union contract on the project. The strike failed of its objective when a majority of the men returned to work, joining the independent Green Mountain Workers Union. Warner Construction Co. is contractor.

A STRIKE on another reclamation project, the Roza irrigation job near Yakima, Wash., was more successful. Contractors there signed a contract with the AFL hodcarriers and laborers union providing a rate of 65 cents an hour, 2½ cents higher than the previous rate, and agreeing that most of the men hired will be local residents.

A WASHINGTON state highway project near Washougal was shut down Apr. 5 by a strike, union officials claiming that A. Milne Construction Co., the contractor, was violating the union's agreement with the Associated General Contractors, of which Milne is a member, by employing non-union men.

THE STRIKE of plumbers in New York City was terminated early this month when members of the United Association of Plumbers and Steamfitters, AFL, agreed to continue working under the terms of the existing contract—a six-hour day at $2 an hour—pending negotiation of a new contract. The strike was called when employers demanded that the union agree to a seven-hour day at $1.80 per hour.

• • •

### *Labor Rates Delay Tunnel Bid Call*

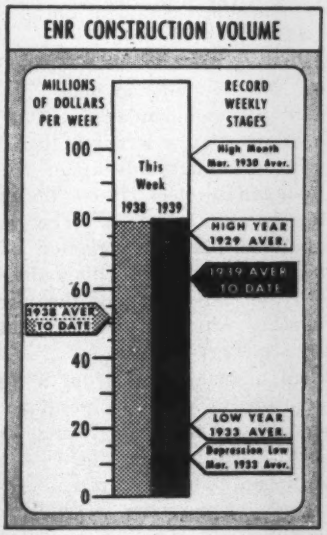
Call for bids for driving the 13-mile tunnel under the Continental Divide has been postponed until about June 1 by the Bureau of Reclamation because of difficulty in establishing labor rates. Preliminary contracts for roads to the east and west portals of the tunnel have been let to the Driscol Construction Co. and the J. H. & N. M. Monaghan Co.

# CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $80,867,000, are the fourth highest of the year, are 40 per cent higher than a week ago, and are 2 per cent above the corresponding week in 1938. This is the fourth consecutive week in which current values have exceeded those of a year ago.

Construction volume for 1939 to date totals $939,593,000, an increase of 21 per cent over the $773,609,000 reported for the 15-week period last year.

Private awards for the week are 79 per cent above last week, but 61 per cent below a year ago. Public construction tops the preceding week by 31 per cent, and the 1938 week by 132 per cent.




Four large street and road lettings in Ohio totaling almost $22,000,000 are largely responsible for bringing highways to the highest weekly volume on record. Commercial building and large-scale housing volume, $17,738,000, is the highest since the corresponding week last year. The high total is due primarily to an $11,000,000 residential development project in Jamaica and Kew Gardens, New York. In addition to highways and commercial building, sewerage, bridges, and unclassified construction record gains over last week. Sewerage, bridges, public buildings, and highways are above the respective volumes of a year ago.

New capital for construction purposes for the week, $5,676,000, is 8 per cent higher than in the corresponding 1938 week. The week's total is made up of $4,889,000 in state and municipal bonds, $619,000 in corporate securities, and $168,000 in RFC loans for public construction.

New financing for the year to date totals $548,211,000, an increase of 21 per cent over the $454,275,000 volume for the initial 15-week period in 1938.

*Tables on p. 31.*

# BRIEF NEWS

FIVE MANUFACTURERS of corporation stops and curb stops have been ordered by the Federal Trade Commission to cease combining or conspiring to fix prices and to cease submitting uniform bids and using coercive methods to compel jobbers to maintain prices. Companies named are: Mueller Co., Decatur, Ill.; A. Y. McDonald Manufacturing Co., Erie; Farnan Brass Works Co., Cleveland; and Kitson Co., Philadelphia.

TWO WORKMEN on the Tacoma Narrows Bridge near Tacoma were injured April 5 when a derrick boom buckled. The steelwork and concrete for the piers is being erected in 12-ft. lifts, two derricks lifting each other to the top of each new stage. The 80-ft. boom of one derrick buckled while it was lifting the other, dropping the second derrick into the steelwork of the caisson. The accident will delay the work about ten days.

FEAR of excessive wave action has led the U. S. Engineers to change the plans for the Great Salt Plains flood control dam near Cherokee, Okla. The crest of the dam will be raised 4 ft., to a height of 61 ft., while the spillway elevation remains unchanged. Work on the earth dam began last October and is expected to be completed in 1940. O'Dell & Riley are the contractors.

FRANK J. WHELAN, former field engineer for the Buffalo, N. Y., department of public works, was acquitted late last month of charges of participating in city payroll padding in 1937.

CONSTITUTIONALITY of Indiana legislation permitting municipalities to set up local housing authorities was upheld last month by the state supreme court. This brings to thirteen the number of state supreme courts which have upheld the validity of housing legislation.

THE PUMPING PLANT at Grand Coulee Dam will be put under construction about June 1, according to Consolidated Builders, Inc., the contractors. Twelve 500-ft. tunnels leading from the site of the plant to the Grand Coulee will be ready this month. The Coulee will function as the reservoir for the Columbia Basin irrigation district. The pumping plant will contain twelve 16,000-sec. ft. pumps, each powered by a 65,000-h.p. motor.

*Further news on p. 84*

# COMMENT AND DISCUSSION

*Readers' opinions on matters that concern the engineer*

## Keep the Door Open

Sir: In your editorial "Keep the Door Open" in the March 16 issue, you comment on a proposed amendment to the engineers' license law in New York State. Permit me to point out the following pertinent facts:

1. The proposed amendment was not intended to add any mandatory requirement. The present law, by the same appearances, could be represented as making it mandatory for every candidate to be a graduate of an accredited engineering school, if we overlook a subsequent clause which states "In lieu of such graduation, an applicant may be admitted . . ." Similar customary legal construction is followed in the proposed amendment. The same board of examiners that applies the present law to "Keep the Door Open" to men who never had any formal schooling at all can safely be trusted, under the proposed amendment, not to close the door to men who have not had the benefit of six years of college education.

2. The objective of a professional licensing law is not mere "ability to design safe structures." *Public welfare* should be considered, beyond the narrow limitation of safety of life, health, and property. In the words of a resolution adopted by the National Society of Professional Engineers: "The highest interests of public welfare and safety are not best served by men whose schooling has been confined to the technical without the development of social perspective, character and intellectual breadth through an adequate foundation of liberal and cultural education."

3. You conclude your editorial with the oft-repeated thought that the measure of a man's ability "should not be how or where he obtained his training but what he knows when he comes to the license board for examination." I submit that no examination thus far devised can be a full measure of professional qualifications, nor can it replace or test the full value of a well-rounded professional and technical education and of the subsequent maturing through practical experience. I know that opinions differ on this subject, but I believe that most of the leaders of the profession would refuse to accept examinations as the all-sufficient requirement.

In conclusion, permit me to make it clear that I personally, as one who came from poverty, want to "Keep the Door Open" for the poorest boy of high aptitude and ambition to secure education and attain admission to the engineering profession. This however is not inconsistent with my desire to offer every possible inducement, in partial compensation, to encourage prospective engineers, to the extent of their resources and abilities, to equip themselves with a better-rounded and more complete education in preparation for their professional life-work.

D. B. STEINMAN
*Consulting Engineer*
*Member, N. Y. State Board of Engineering Examiners, New York*

The editors are in hearty agreement with Dr. Steinman's desire to see all engineers as broadly educated as their circumstances permit. However, such broad general training is not essential to the protecting of the "life, health and property" of the people of the state, hence the power to require it arbitrarily should not be placed in the hands of a licensing board, however benevolent its present members may be. The present New York State law, to which Dr. Steinman refers, is just as defective in this respect as is the proposed amendment. Its requirement of four years of college training was hastily written in a few years ago and is by no means sacrosanct.—EDITORS.

Sir: Your editorial "Keep the Door Open" deserves the commendation of all engineers.

In analyzing any proposed legislation affecting the profession of engineering, it is well to consider whether the proposed restrictions will benefit the engineers or the community. Legislation that would deprive qualified engineers the opportunity of following through their pursuits to the advantage of the community should be rejected by all engineers. We can fully endorse your opinion that "the measure of a man's ability to design safe structures should not be *how* or *where* he obtained his training but what he *knows* when he comes to the license board for examination." Clearly the proposed Desmond Bill contributes nothing to the promotion of higher professional standards; if anything it lends itself to the exclusion of capable engineers from being licensed and this, in effect, becomes discriminatory legislation.

The Federation of Architects, Engineers, Chemists and Technicians has favored liberal licensing laws which set adequate standards for the protection of the community following the nature of the high skill required in engineering work. It is our desire to see all those who are qualified in engineering given the fullest opportunity of practicing their faculties and advancing to such positions as their education and experience properly warrant.

MARCEL SCHERER
*International Vice-President, FAECT*
*New York*

## Going on Fifty Years

Sir: In going through my diary I came across the following entry: "September 17th, 1890—In evening read *Engineering News* and made notes." And I am still at it.

LEONARD C. L. SMITH
*Consulting Engineer*
*Flushing, N. Y.*

## Riveted Joints

Sir: An added comment on "Tests of Large Riveted Joints" in your issue of Feb. 16 may be of some interest. Note is made, in item (7) of the design recommendations, that in spite of its greater strength there is not a proportionate advantage in using manganese steel rivets "because of the greater slip . . ." The friction between plates in a riveted joint is an important factor. This action is due to the contraction of the rivets on cooling which draws the plates tightly together.

When a metal cools from a high temperature to room temperature it passes through the critical range and a transformation, called the $(\gamma - \alpha)$ transformation, takes place. During this process the crystals, of

which the metal is made up, change from the face-centered lattice to the body-centered lattice with a consequent increase in volume. During this transformation the metal expands while the temperature drops, thereby causing a decrease in the gripping action. For rivet steel, this transformation starts at about 720 deg. C. which is above the finishing temperature for the riveting process.

However, some of the alloying elements used in steel tend to lower this transformation range along the temperature scale, for example nickel and also manganese. The $(\gamma - \alpha)$ transformation for nickel steel (3 per cent) starts at about 550 deg. C. and this is lower than the finishing temperature of the rivets. The result is a considerable reduction in the gripping action of the rivets and therefore more slip in the joint. On the other hand a low carbon 12 per cent chromium steel has its $(\gamma - \alpha)$ transformation from about 790 deg. C. so that with such rivet steel a greater gripping action would result; in fact perhaps too much.

Fatigue tests on riveted joints indicate that the gripping action of the rivets is even more important than for static tests and show a decided superiority of plain carbon steel over nickel steel.

I. F. MORRISON
*Professor of Applied Mechanics*
*University of Alberta*
*Edmonton, Alberta, Canada*

## Floor Slab Patents

Sir: The letter of George E. Strehan (referring to the use of steel column heads in the flat slab floors of the Williamsburg housing project in New York City) in your issue of Feb. 16, 1939, p. 203, calls for a further statement. The payment made by Starrett Bros. & Eken was "for settlement of all claims for infringement of the patents in suit arising out of Williamsburg Housing Project H-301, as set forth in the petition herein." In addition Starrett Bros. & Eken paid the costs. The release was to the United States Government and Starrett Bros. & Eken.

Application for Wheeler patent No. 2,000,543 was dated Nov. 3, 1930, and patent issued May 7, 1935. Application for Wheeler patent No. 1,950,422 was dated Feb. 18, 1931 and issued March 13, 1934. Application for Strehan patent No. 2,033,595 was dated July 21, 1931 and patent issued March 10, 1936. Hence Wheeler patents are prior both as to date of application and date of issue.

The embedded steel column head of the Wheeler patents, and also of the Strehan patent, is primarily a shear member which transmits the load of the floor or roof slab to the columns. This steel head also assists the slab to resist bending near the column. These embedded steel column heads necessarily perform these functions in the structure regardless of what basis of design is adopted for the slabs and columns.

Mr. Strehan asserts that his patent is not an infringement of my patents. I assert on the contrary that it is an outright infringement and that anyone making use of it is making himself liable to me for royalty. The issuance of a patent by the patent office affords no presumption or implication that the patented structure does not infringe prior patents.

Some 40 buildings have already been constructed in the United States using the Wheeler patents, 5 more are under construction at this writing, and several are being planned. The spans in these buildings range from 12 to 35 ft., and the slabs are designed for live loads ranging from 40 to 350 lb. per sq.ft.

WALTER H. WHEELER
*Consultant Engineer*
*Minneapolis, Minnesota*

## Pavement Design Correction

Sir: In *Engineering News-Record*, March 30, 1939, under the title "What Research Tells Pavement Designers," you have quoted the conclusions from the paper that I presented recently before the American Concrete Institute.

In the second sentence of conclusion No. 8 several words have been omitted, which completely changes the meaning and conveys the thought that I have a rather poor opinion of the merits of steel reinforcement when, as a matter of fact, exactly the reverse is true. In my opinion, the most adequate pavement designs are those which provide for the use of distributed steel reinforcement.

As printed this sentence reads: "The introduction of properly designed steel reinforcement in long slabs will not completely eliminate the detrimental effect of the cracks which may develop." It should have read: "The introduction of properly designed steel reinforcement in long slabs will not completely eliminate transverse cracking but it will reduce or eliminate the detrimental effect of the cracks which may develop."

E. F. KELLEY
*Chief, Division of Tests*
*Bureau of Public Roads, Washington, D. C.*

## Why Unit Price Bids?

Sir: The appearance of a discussion of unit price bids in your pages ("Why Unit Price Bids?" *ENR* March 16, 1939, p. 391) is encouraging, but the content of the article belies the promise of its title. Restriction of discussion to architectural work severely limits the interest of the comments presented. The arguments used to disparage the benefits suggested are all debatable, but that relating to monthly payments is surely erroneous. The fact that with unit price bids "payments must be made in a certain manner" is surely, in general, a very real advantage in enabling all parties concerned to know where they stand in this regard before work commences.

The evils cited are two only in number. The first depends either on grossly inaccurate quantities or unethical practice on the part of an engineer (features which, it may be hoped, are the exception rather than the rule), and the second relates to the cost of preparing unit price bids. It may well be asked how an intelligent bid can be prepared other than on the basis of carefully evaluated unit prices, the entry of which on a tender form should not be a very costly matter.

It is to be hoped that the article in question will at least promote discussion in your pages since, despite the many advantages of the lowest-tender unit-price contract for engineering work, the system is not perfect. One prominent Canadian contractor has several times voiced to the writer his opinion that the ideal type of contract would be one based on unit price bids, the award going to the tender which was found to be closest to the *average* of all bids received. Impracticable? Possibly, but more logical than the generally accepted system and so at least worthy of discussion.

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# ENGINEERING NEWS-RECORD

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*APRIL 13, 1939*


RARELY does a bridge failure have as shocking aspects as the Clear Creek bridge collapse near Vicksburg on the evening of March 29. The technical aspects of the disaster are as bad as its human tragedy. If the preliminary finding of the investigating engineers is confirmed by fuller examination and established firmly—that the bridge was wrecked by destruction of its trestle-bent posts by the pressure of flood drift—it will put on record a new warning of the danger of unexpected contingencies. So far as we recall no prior case is on record in which solidly constructed reinforced-concrete bridge bents were wrecked by flood drift, and ordinarily the strength of such bents would be sufficient to resist any probable drift or impounding effect. Reexamination of other structures of the type to detect any weakness under abnormal drift and flood conditions therefore appears advisable, and new bridge construction should by all means take account of the possible destructive forces indicated by the tentative finding on the Clear Creek accident. However, before the book is closed on this case it is to be hoped that complete certainty will be obtained on the condition of foundations and other parts of the structure so that no question will be left as to the responsible causes.

## *Safety Guide Lines*

AN OUTSTANDING FEATURE of the Clear Creek disaster was that the loss of life resulted not from the failure itself but from the subsequent fact that a dozen cars in succession ran into the washout gap without warning or suspicion. Could a like result be prevented in another case? This is a proper question to add to the many others in the field of road safety now engaging the attention of engineers. One principle may be set down on the basis of general experience, namely that safe traffic movement requires the line of the roadway to be clearly discernible for some hundreds of feet ahead. When the line of the road can be distinguished, any break in its continuity will be observable, and the fatal unconsciousness of danger of those who drove into the Clear Creek torrent would not be repeated. Clearly visible marking of the curb line or edge of roadway, of a kind to show under night as well as day conditions, appears to be a primary safeguard. The many roads throughout the country that lack both edge and center guide marking are a daily illustration of one major traffic hazard, and the unusual circumstances of the Mississippi accident further emphasize its gravity.

## *Mining Deep Seams*

SEAMS OF UNSOUND ROCKS at damsites have always presented engineers with difficult problems in making the dam foundations tight, and in the past they have held up work on the dam while the seams were cleared out and concreted. Eleven years ago, when the construction of the 390-ft. high Owyhee dam was undertaken, it was found that a narrow fault zone in the canyon would have to be concreted to at least 100 ft. below the general level of the dam foundation. To keep that slow work from holding up work on the dam it was decided to put in the main foundations and then mine the fault while construction of the dam was in progress, replacing the shattered material with concrete. The method proved successful. A few years later it was used on a deeper and wider fault zone under Rodriguez Dam in Mexico. Both that fault zone and the one at Owyhee ran lengthwise of the valley. At Seminoe Dam in Wyoming two fault zones were encountered, one roughly lengthwise of the valley and one running across the valley. These seams also were mined after work on the superstructure of the dam had begun, but new methods of attack were developed, as told in this issue. The elaborate provision for grouting to minimize the effect of shrinkage of the concrete deposited in the seams is notable. What was a novelty ten years ago is now accepted practice under recognized methods of procedure.

## *Another Tax on Construction*

SETTING UP preferential rates of unemployment insurance for employers who have stable employment records, as proposed by the New York State Employers Conference, is strongly opposed by the Building Trades Employers Association of New York City as placing an unfair tax on the construction industry. Similar preferential rates have been proposed in other states. As the New

York builders point out, employers in the construction industry have no control over the regularity with which they provide jobs; that is set by the market for construction services. Because legislation such as is proposed in New York and in some other states puts a tax on the construction industry for a condition over which it has no control that legislation should be opposed nationally by the Associated General Contractors and by other building trades employers' associations, to say nothing of the building trades unions themselves. The proposed preferential rate is being pushed by employers who have little seasonal unemployment. They are strong numerically and are better organized than is the construction industry. If the units of the construction industry do not want to be saddled with a new discriminatory tax they should make themselves heard in opposition to this movement.

## No TVA Policy

LITTLE of real value is found in the voluminous report of the joint congressional committee set up to investigate the Tennessee Valley Authority. From the start of the committee's operations the work took on a partisan nature. That unfortunate circumstance is fully reflected in the findings, those of the majority being so diametrically opposite to those of the minority as to make it evident that the committee as a whole did not give dispassionate consideration to the mass of data placed before it.

Only as to the high quality of the engineering work was the committee in agreement. But the quality of the engineering never was in question. What the nation had good reason to expect from the committee was a considered finding as to whether regional development as envisioned in the TVA act could be carried out successfully with the independent organization set up in the act—given a set of directors who could work together in reasonable harmony—or whether the development could be handled better through an agency or agencies more closely integrated with existing state and federal agencies.

And, of course, there should have been a definite finding on the matters of power policy and power rates. Unanimous agreement on such a controversial question was not to be expected, but available information as to present methods of allocating all costs having any bearing on power costs could have been set down and then the committee could have recommended to Congress how they should be allocated depending on whether Congress decided to adopt a power policy under which power is to be made to appear cheap through the use of hidden subsidies, or whether power rates are to cover all costs.

Personal antagonisms of the directors, accounting practices, methods employed in the purchase of phosphate lands, and even the ill-smelling marble leases, are of minor importance except as showing that any large government undertaking must be carried on with the utmost openness. A dispassionate analysis of past activities of the TVA with a clear statement of wherein its organization appears to be weak or strong, as the case may be, would have provided the basis for a finding by Congress as to what the future of the TVA should be. The disagreement between the directors which started the Congressional investigation found its origin in the lack of a definite statement of policy in the TVA act. If that disagreement did nothing else, it did show that Congress, not the TVA directors, must fix national policy in the Tennessee Valley.

## Rio Grande Water

PLANNING for a main canal and reservoir system for the lower Rio Grande as recorded this week (p. 487) represents an important first step toward solving a serious problem. At present half a million acres are supplied with irrigation water by individual pumping plants out in the river. This supply is periodically in danger of being cut off by flood destruction, and in addition it fails in years and months of exceptionally low flow (*ENR* Nov. 3, 1938, p. 555). This condition is sure to become more frequent as Mexico uses more of its tributary water and as the flow from the American tributaries is more fully stored and used.

The risk of an American shortage has been increased by the Retamal flood-diversion gate recently built by Mexico, but this risk would be removed by a canal taking its supply well above the gate. Competitive reaching upstream cannot increase the river's flow, however, or change the hard fact that more permits for water have been issued than the river can now supply. Ultimate solution of the problem will depend on storage of wasted floodwaters by dams across the main river. However, before the available supply can be thus increased the lack of determination of water priorities of Texas lands may create an acute situation.

FIG. 1. MESH-REINFORCED LIP CURB AND GUTTER WERE POURED SEPARATELY ON INDIANA DUAL ROAD

# New Devices For Curb Construction

ROBERT M. ANDREW

Project Engineer, Indiana Highway Commission, Indianapolis, Ind.

***Contents in Brief—Old 30-ft. concrete pavement resurfaced and widened to a 52-ft. concrete dual road with sidewalks. Lip side curbs and a curbed separating strip between roadways were constructed separately by ingenious devices produced on the job.***

FIVE MILES of dual road built last season in Indiana presented several problems in carrying out center-strip and curb details that were solved with exceptional ingenuity. This article is mostly an account of these individual processes and of the special construction devices developed by the contractor and the road engineers to make them rapid and easy. As shown by Fig. 2, the main operation was resurfacing and widening an old concrete road. Besides the usual paving, there were 5 mi. of separating strip, 10 mi. of gutter and 7 mi. of sidewalk, all separate operations from the paving proper.

The dual road consists of two 22-ft. pavements with a 2-ft. lip gutter at each outer edge and a 4-ft. raised concrete center strip dividing the two lanes. The pavement was laid over an existing 30-ft. pavement built in 1916; this called for 20 ft. of resurface on one side of the center strip, 6 ft. of resurface on the other side and 16 ft. of new paving on new subgrade. The slab was laid with two 27E pavers, one with skip ahead and the other with skip behind; the front paver placed the concrete on which the reinforcing mesh was laid after which the second paver placed the top. The highest production was 2,417 lin.ft. of 22-ft. slab in 8¾ hr. during which 970 cu.yd. were poured by the two pavers.

The minimum thickness of resurface was 5 in., and since one form line for each lane of resurface came on the old pavement, 5-in. forms were used. To reduce the amount of drilling for form pins, brackets adjustable from 24 in. (Fig. 3) were used and one line of holes was drilled 2 ft. from the form lines. All expansion joint fillers had to be cut at the site to fit over the old slab. A wooden templet with stub dowels at the standard dowel intervals was made and the joint material, which had been punched by the producer, was fitted over the stubs and the assembly placed at the joint location and 2 in. above grade. A knife fitted to a 2-in. block for grade was moved across the pavement to score the filler, which was then removed from the holder and cut to the knife marks.

### Special tools for gutters

The lip gutter was tied to the pavement with bars at 5-ft. intervals and was reinforced with mesh which made it necessary to place the concrete in two courses. As no face form was used in placing the top, considerable difficulty was had in holding

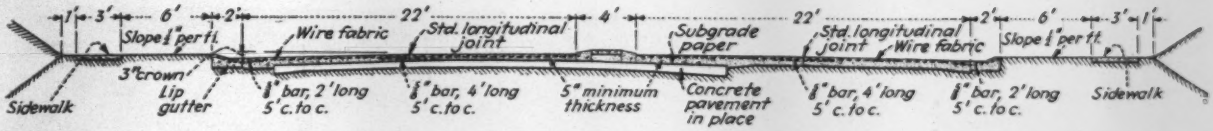

1' 3' 6' 2' 22' 4' 22' 2' 6' 3' 1'
Slope 1" per ft.
Wire fabric
Std. longitudinal joint
Subgrade paper
Std. longitudinal joint
Wire fabric
Slope 1" per ft.
3" crown
Sidewalk
Lip gutter
⅝" bar, 2' long 5' c. to c.
⅝" bar, 4' long 5' c. to c.
5" minimum thickness
Concrete pavement in place
⅝" bar, 4' long 5' c. to c.
⅝" bar, 2' long 5' c. to c.
Sidewalk

**Fig. 2.** New 52-ft. dual pavement, with sidewalks, tops and widens old 30-ft. concrete road entering Indianapolis, Ind.

the contour of the gutter without leaving a large amount of honeycomb. This was largely overcome by the use of a strikeoff, Fig. 4, extending 6 ft. along the gutter and equipped with a vibrator. The leading edge was shaped to allow feeding in the concrete. The strikeoff was pulled by truck when pouring was done with truck mixers (Fig. 1) but with a change to paver pouring the pulling was done by a drum on the paver.

Finishing the gutter was facilitated and improved by using templets to guide the straight edging; these were made of ½-in. tees, shaped to the curved cross-section of the gutter, and were of sufficient strength for the work but were small enough to leave no large depression when removed. Progress on the gutter averaged 2,200 lin.ft. per 8 hr., with days of 3,300 to 3,900 ft. for a maximum.

### Colored center-strip problems

The dividing strip (Fig. 5) consisted of two 12-in. curbs with 2 ft. of black concrete between them. The rise on the face of the curbs was 1 in. with a slope of 1 on 4 across the top, the black concrete being graded from curb to curb. The contract was set up for four types of curb: yellow, plain, white with local aggregate, and white with marble aggregate. A fifth, white with marble coarse aggregate and limestone fine aggregate, was added for the last 2,000 ft.

In building the center curbs, 10-in. road forms, spaced with the adjustable clamps used for the resurface pavement forms, were used (Fig. 6). The pin on the brace was locked in one form pocket and a form pin was locked in the opposite form pocket and the brace pocket.

The top of the road form was set 1 in. above the top of the curb. From this form, braces (Fig. 7) extended over the curb area to hold the face forms which were 1x2-in. channels. These braces were welded to the channels at the beginning, but it was found much better to allow the face form to be free to follow the pavement surface and use the braces only for line. This was done by making sheet metal clips with a snug fit over the channels. This also gave the finishers more freedom since the braces could be removed yet the channels left to give the grade of the top.

The colored curbs consisted of a 1-in. top on a plain concrete base.

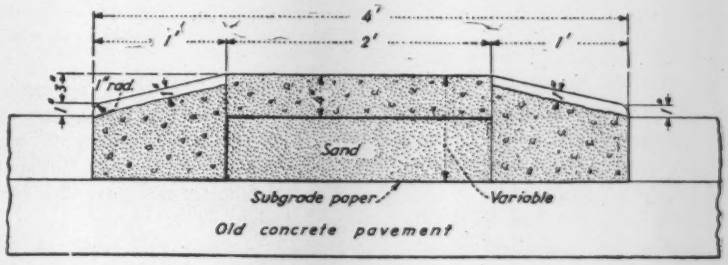



**Fig. 5.** Center curb constructed on old concrete slab separates the two halves of the new dual road.

To strike off this base, a wheeled strikeoff (Fig. 8) was developed which shaped both curbs at one trip. This rode on the pavement and was pulled by the paver used to pour the base. The topping was mixed with a two-bag mixer and the operation was kept close enough to secure good bond. The striking and finishing of the top was done with a special hand tool that rode on both back and face

**Fig. 3.** Extensible braces enable sideforms resting on the old concrete pavement to be held with one line of pins; the space between forms will be filled by curbs shown in Fig. 5.

**Fig. 4.** A vibrating screed 6 ft. long was pulled ahead by the paving mixer as concrete was shoveled in front of it to shape the lip curb and gutter to exact ogee section.

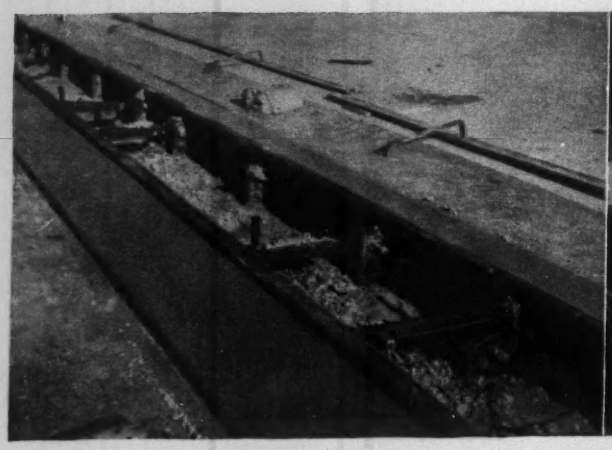


Fig. 6. Curbs for the separating strip were built first using two standard steel slab forms for back forms supported by extensible braces shown in Fig. 3 without drilled pin holes.

Fig. 7. Colored concrete topping (gray, white or yellow) was troweled onto the center-strip curbs using a templet riding on the back and face forms.

form, Fig. 7. This trowel was shaped to form both edges of the curb, as well as finish the top, but it was found desirable to follow up with common tools in all cases.

No difficulty was found in finishing the yellow top, although unusual care had to be exercised to secure good line with a trowel finish. On the gray or plain curb, it was found desirable to change from one-course curb to a topped curb, leaving out all aggregate over ½ in. in the topping. It is probable that a float finish could have been made without this change, but a trowel finish was very difficult to secure and not satisfactory when the large aggregate was used. The white with local aggregates (gravel coarse aggregate and limstone fine aggregate) finished with no difficulty and gave the best trowel finish of all types.

Before pouring the curb, curing paper was placed on the pavement and folded down over the edge to prevent staining the pavement. This paper was covered with a second layer of paper during the pouring and finishing to prevent wearing holes in the curing paper. After finishing, the curing paper was pulled over the top of the back form and fastened with clothes pins. When the back forms were pulled, this paper was folded down over the curb and sand was placed between the curbs and wet down. Production of curb varied from 1,400 ft. to 1,800 ft. normally, with a high day of 2,076 ft.

In pouring the black strip between the curbs, the paper used to cure the curbs was left folded in to prevent stain on the curbs. This worked very well and stood the wear of finishing the center without failing, except for a short stretch caught in a rainstorm. The concrete was poured with transit mixers and the operation represents nothing unusual. The mixture consisted of regular curb concrete with 7 per cent of liquid coloring added as the mixers were charged. About 3,300 lin.ft. (6,600 sq.ft.) was a day's run.

This road is the first on which Indiana has built sidewalks connecting two cities; the major portion was a 3-ft. walk set 6 ft. back of the lip gutter. This work gives a continuous pedestrian lane from Cumberland to walks inside the city; yet the first accident after the road was opened involved a pedestrian walking on the pavement after dark. The sidewalk was poured with a 27E mixer with chute and formed with wooden forms. The best day's pour was 4,593 ft. of 3-ft. walk (4 in. deep) with an average of 1,100 sq.yd. per day.

The work was performed under the Greenfield District staff of the Indiana highway department, D. L. Horner, district engineer. The cost of the project was $440,000 for 5 mi. of divided-lane road and ½ mi. of 58-ft. street.

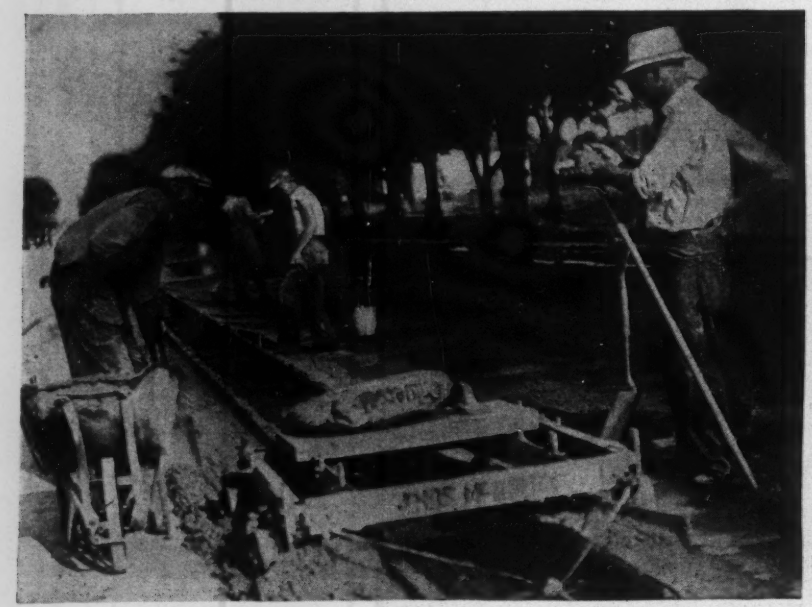


Fig. 8. A traveling strikeoff shaped the base concrete of the center-strip curbs for placing the colored top course.

# Water for Lower Rio Grande Valley

*Studies of American reservoir sites follow recommendations of special engineering board*

ELIMINATION of shortages of irrigation water in the Lower Rio Grande Valley by means of storage reservoirs on the American side of the river is under study by the engineers of the U. S. Section of the International Boundary Commission, as a result of recommendations made by a special engineering board. Reservoirs would be located on tributary streams and filled by a main river pumping plant. Feeder lines would connect the reservoirs with the existing irrigation system.

Warnings of a water shortage made in an article in *ENR* p. 555, Nov. 3, 1938, are fully substantiated in the following statement in the report: "The irrigation demands on the Rio Grande and its tributaries below Fort Quitman have increased to such an extent that at times the river is dry at the pumping plants which serve Lower Valley lands. At three times in 1938 there was little flow in the river at Mercedes and none below San Benito.

"During June, 1938, the irrigation districts were forced to prorate the supply and to limit its use to domestic purposes."

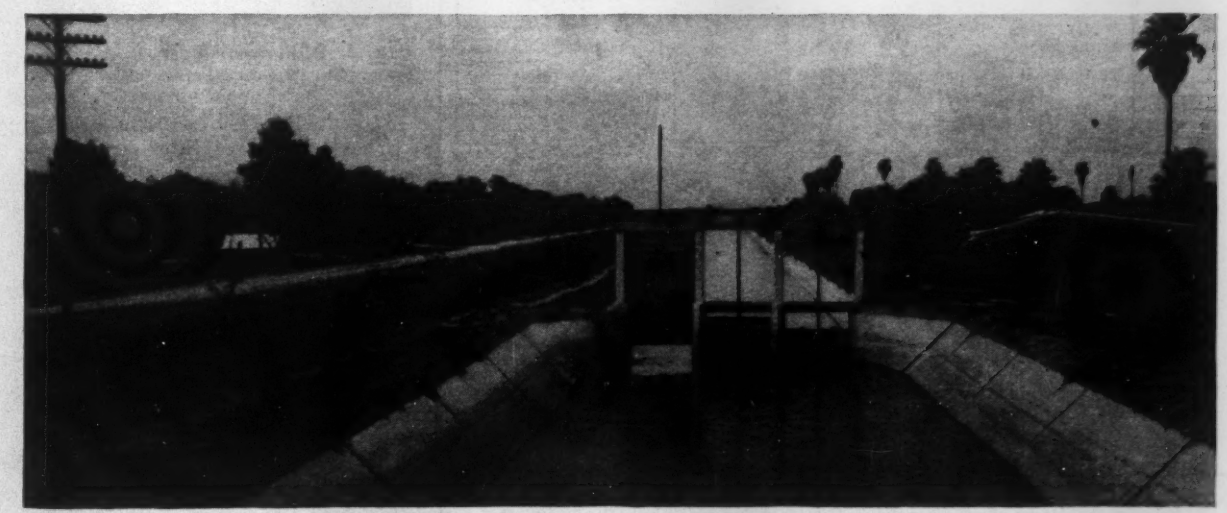
Also, increasing use of water in Mexico, as described in the same article, is affirmed. For example, the Retamal headgate opposite Donna, Tex., so the report states, will begin at once to divert water for 5,000 acres; the sill being 3 ft. below the river bed, as much as 3,500 sec.-ft. can be diverted at flood stage. Mexico has brought areas under irrigation at the rate of 12,000 acres annually until more than 600,000 acres are now under constructed works. The report further points out in support of the reservoir recommendation that the majority of the 17 existing pumping stations are 20 years old or more and will require renewal soon.

The board, in its report, dismissed plans for rectification or stabilization of the river as too costly at this time and then outlined for consideration five storage reservoir plans as follows: (1) Reservoirs on the Pecos or Devils River; (2) Small storage reservoirs for each of the 17 districts; (3) Small riverside storage facilities near the Mission inlet to the floodways; (4) Master pumping plant at head of the irrigated area, to replace 14 existing plants, with storage as in (1), and a gravity feeder canal; (5) Reservoirs (400,000 acre-ft. probable) on tributary streams, Del Tigre and Los Olmos, to be filled by a master pumping plant on the main river.

The first four plans are found to be without sufficient merit and only the tributary reservoir plan was recommended for further study and investigation.

Basic data governing the location and design of the proposed works were set down by the board as follows: Because of the limited water available the land served should not exceed that within existing districts—861,604 acres of which 715,000 acres are "active." Since flow in critical low years may not exceed 1,250,000 acre-ft. the duty of water should be 1.75 acre-ft. per acre, corresponding to the actual average duty for the past 7 years. The feeder canal capacity should be set at 0.36 acre-ft. per acre per month. The inlet canal capacity depends on studies of the daily river hydrograph but would probably be 3,000 to 4,000 sec.-ft.

As a result of the recommendations of the board, the Boundary Commission engineers, using a $70,000 allotment, are: 1. Making studies of sites for a master pumping station together with cost investigations of canals leading from these sites, which would include determination of rela-



One of the canals feeding 40,000 acres of citrus fruit land in the Lower Rio Grande Valley.

tive economy of higher pump lifts as compared with longer canals; 2. Investigating costs of pumping plants and dams and preparing tentative designs; 3. Completing surveys of the Los Olmos and Del Tigre reservoir sites with particular reference to their geophysical suitability for storage. 4. Studying feeder sites and costs.

The personnel of the engineering board was as follows: R. J. Cummins, engineering adviser representing the RFC (which with other federal agencies has $30,000,000 loaned in the Rio Grande Valley); A. Tamm, consulting engineer, representing the Conservation Association of the Lower Rio Grande Valley; and four representatives of the Boundary Commission — J. L. Burkholder, senior engineer and chairman of the board; E. N. Noyes and H. E. Elrod, technical advisers, and J. L. Lytel, project engineer.

# Half Soles Save An Old Sewer

E. M. Van Gelder

Superintendent of Sewers, Rochester, N. Y.

***Contents in Brief** — A novel method of repairing a disintegrated sewer invert was devised in Rochester using an inner lining of corrugated iron flume. The lining, bent in the shape of a half circle, was bolted in sections and installed without interrupting sewer service.*

HALF-CIRCLE SECTIONS of corrugated iron flume have been used successfully to reline the disintegrated invert of an old brick intercepting sewer in Rochester, N. Y. The lining was installed without interrupting service, and no special tools or skill were required. It is believed this is the first time a sewer invert has been repaired in this way.

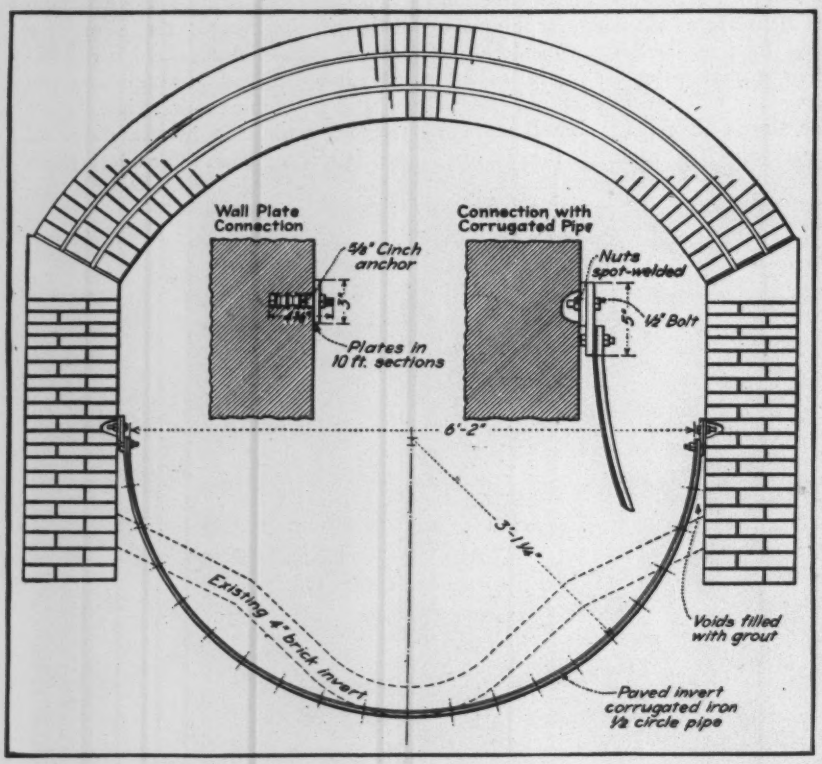



**Fig. 1.** Novel method of relining the invert of an old brick sewer using "half soles" of corrugated iron.

**Fig. 2.** Disintegration of brick lined invert threatened collapse of the side walls.

The sewer is of brick arch construction and was built in 1894. Leaching of the cement-mortar permitted seepage and softening of the filling material under the brick invert with the result that undermining, settlement and some heaving took place throughout a length of about 1000 ft. Conditions had become so bad that extensive repair of the invert was necessary in order to prevent entire collapse of the structure.

The sewer carries both storm water and sanitary waste, and drains a very hilly area which contributes a large and rapid runoff. It was necessary,

therefore, to use a re-lining material that could be placed while the line was in service and yet could be left quickly and not be damaged in case of rain. To meet these requirements the city engineering department recommended the use of half-circle sections of asbestos-bonded corrugated iron flume, bituminous coated and with inverts paved with the same material—fastened to special plates on the side walls of the old sewer. The following installation methods were used.

### Preparations for repair

In a shaft dug at one end of the damaged section of sewer a hoisting engine and other construction facilities were erected. An industrial railway track was laid in the invert of the sewer and a flat car was used for handling materials.

A dam about 4 ft. high was then built at the upper end of the work, and a bypass line of corrugated iron pipe was laid to a point below the extreme reaches of the proposed work. An 8-in. centrifugal pump was employed to force the sewage to the bypass line. By supporting the bypass line on H-frames spaced about 20 ft. apart, a uniform grade was obtained. Because of a heavy day flow in the sewer, construction operations were carried on in two 8-hr. shifts, from 4 p.m. to 8 a.m. Working in sections of 50 ft. at a time, the brick invert and material beneath it was removed. By using a templet form to fit the outside of the half circle flume section, excavation was kept to a minimum.

The engineers made a survey for the required flume sections by carefully measuring the offset distances from a center-line to the brick wall throughout the length of the job. The pipe manufacturer was supplied with this information so that the flume sections approaching the curves and on the curves could be fabricated to fit neatly. The sections were made 4 ft. long for easy handling.

### Placing the sections

To support the paved invert flume sections, holes were drilled into the brick side walls at regularly spaced intervals for $\frac{5}{8}$-in. cinch anchors. Then 3x$\frac{3}{8}$ in. galvanized plates, 10 ft. in length, were placed on the walls with wedges between the wall and the plates to hold them at the required distance from the centerline.

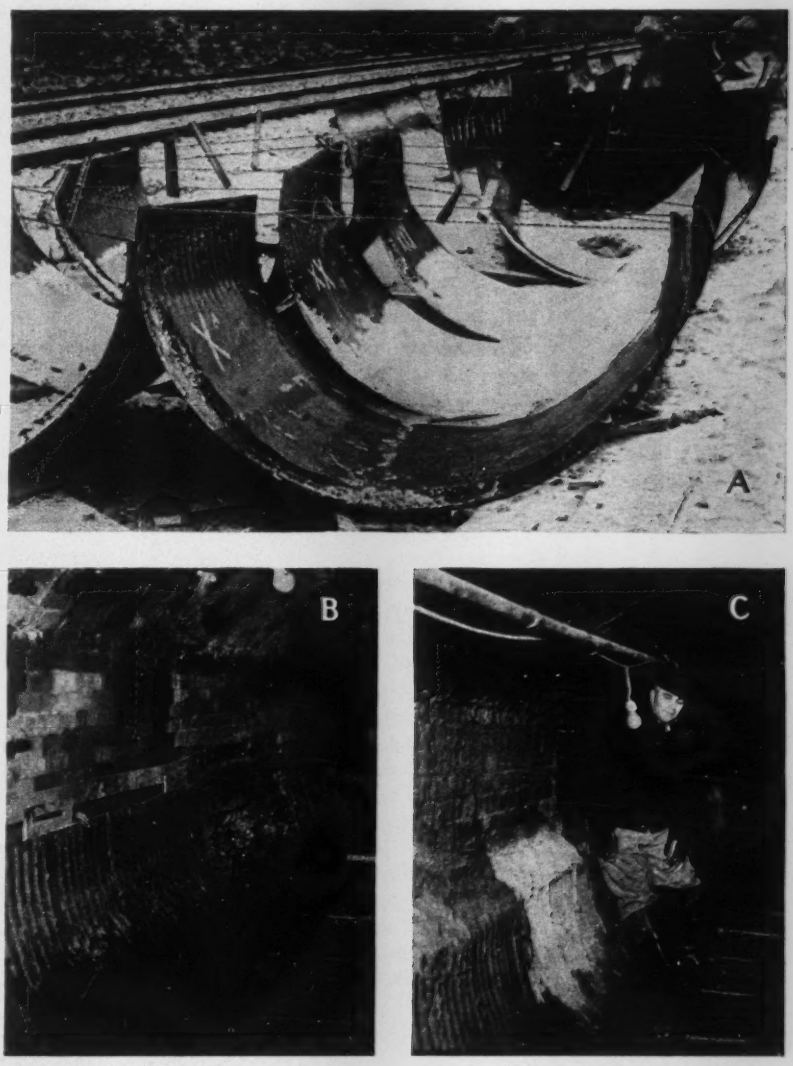



**Fig. 3.** How the job was done: (A) The "half sole" section fabricated to fit; (B) sections fastened to the sewer wall; (c) sand-cement mixture applied to all exposed metal completed the job.

Next, metal plates 16x5x$\frac{3}{8}$-in., on which nuts had been welded, were hung in position by means of bolts through the 10-ft. plates. The half circle flume sections were fastened to the lower part of these plates. The ends of adjacent 4-ft. flume sections were fitted together and then bolted by means of nuts welded on the outside of one end of each section. The circumferential seam was sealed with hot asphalt. When infiltration from house laterals covered these seams, a cold pour material was used for sealing.

To complete the job the voids beneath the flume sections of the invert were filled with a 1:3 mixture of cement and sand applied with a gun. The top edges of the flume sections and all exposed bolts and galvanized plates were covered with this same cement-sand coating.

This work was an ideal wintertime job, because most of the operations were below ground where it was comparatively warm. The job was begun in November, 1937, and completed about mid-April of 1938; the work was not carried on continuously because it was necessary to use the same crew whenever emergency repairs had to be made at other points in the city. Two full crews, of eight men each, were used, all working under the direction of the writer of this article.

The corrugated iron flume sections were fabricated by The Shelt Co. of Elmira, N. Y.

# Mining Under Seminoe Dam

***Contents in Brief — Mining of faulted areas below the base of Seminoe Dam was carried out from galleries in the base of the dam so that concreting would not be held up. Small shafts sunk through the fault zones to depths determined by examination of the rock were used to excavate badly crushed rock in two seams, the seams being filled with concrete as the work progressed.***

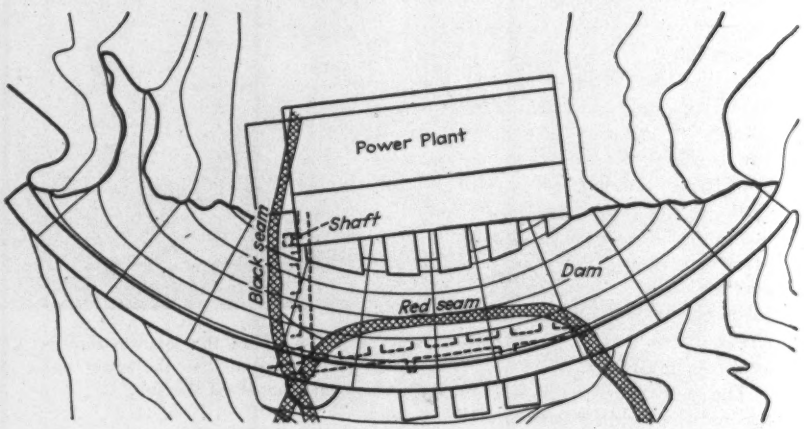
TWO FAULTS normal to each other intersect under the Seminoe Dam of the Kendrick Project in Wyoming. They were uncovered in excavating the overburden from the dam foundation following a slide which is believed to have been precipitated by squeezing of the soft material in the seams at or near the intersection of the faults. The gouge and disintegrated material in the crush-zones was mined from a tunnel or gallery system formed in the base of the dam. Concrete in successive blocks replaced the material excavated from the seams.

Design features and the construction program for Seminoe Dam were described in *ENR*, March 18, p. 395 and Nov. 18, 1937, p. 817. The dam is a concrete arch 260 ft. high set in a narrow rock gorge.

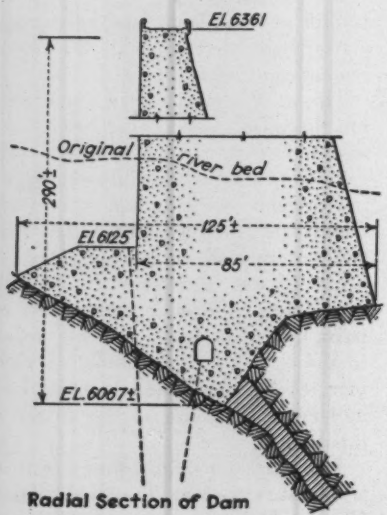
## Geology

The granite rock at the damsite is excessively broken, first by cooling and later by ancient mountain-forming movements resulting in faulting, shearing and close jointing. Measurable displacements have resulted in crush-zones following closely east-west or north-south directions. The average granite is fresh and sound but many of the crush-zones are badly weathered and decayed. A recent report of consultants (Messrs. C. P. Berkey, W. F. Durand, Joseph Jacobs and C. H. Paul) described two such weakness zones which were uncovered in the excavations for the dam. One crush-zone or seam striking nearly east-west and dipping 50 deg. to the north cuts through the portal of the spillway tunnel and crosses the river gorge at the upstream toe of the dam. It dips downstream under the dam. The second fault follows the left bank of the stream and is normal to the first fault. It dips under the left abutment at an angle of 70 deg. The two intersect near the axis at the foot of the west or left abutment.

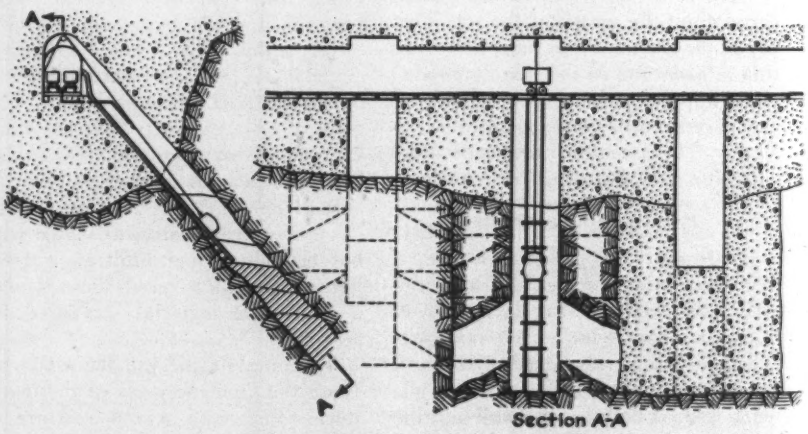
The geology as exposed by the min-




Plan Showing Location of Seams




Radial Section of Dam




Sections Through Mining Galleries

Fig. 1. Position of seams under Seminoe Dam and method used in removing crushed rock from the red seam.

ing operations showed an offset of 20 ft. in the chloritic schist "black" seam. The "red" seam, so-called from the color of the gouge, is a thrust fault indicating a movement approximately 45 deg. with its strike and a resulting displacement of about 60 ft. The hanging wall appears to have moved in a south-east direction with respect to the foot-wall. Both seams are badly decayed and vary in width from 2 ft. to 10 ft. but the hanging walls and foot-walls are hard and acceptably sound rock.

### Treatment of the seams

Roughly, the proposed treatment was to mine out the soft disintegrated material which has no structural strength to such depth as judged safe, probably 30 to 50 ft., this depth to be determined by inspection as the work progressed. Backfill was to be concrete. This method, the consultants stated, should stabilize the foundation and guard against undue deformation under load. In essence the dam rests on a cantilever of rock abutting against the 7-ft. "red" seam; the left abutment is a ledge overhanging the 5-ft. "black" seam.

The fracturing of the abutments, the experts held, is likely to be more pronounced in the immediate walls of the crush-zones and it is this wall rock that they indicate as likely to carry water and develop seepage. For this reason grouting of the rock adjacent to the seams is considered highly important. However, dryness of the hole, 70 ft. below the river bed, is so pronounced that little apprehension of seepage or springs developing when the reservoir fills is felt. The west abutment has many clean-cut and straight joints with wall blocks, virtually unattached to the more sound ledges beneath, hence the grouting must be handled carefully so as not to develop high pressures in the superficial portions of the abutment rock. To offset this somewhat alarming language the consultants firmly state that, after a review of all conditions and of the treatment methods, a safe and efficient structure is assured.

### Stripping

Stripping of the abutments proceeded continuously until the river was diverted through the tunnel Aug. 10, 1937. Thereafter scaling off the cliffs had to be coordinated with the removal of the overburden from the floor of the canyon. The stripping of the loose material and cutting back to the designed profile high up on the cliffs was precarious business completed in November 1937. While removing the last road across the base excavation, cracks began forming 100 ft. up on the left cliff and 100 ft. upstream from the axis of the dam. A slide of 2,500 cu.yd. eventually went down into the foundation excavation. The cliff upstream from the axis was stripped anew. This material did not endanger the abutment face but if not removed would have been a menace to the trash-rack structure on the face of the dam. A ramp was built across the dam excavation, equipment taken upstream and all material scaled back to a 1½ to 1 slope. It was during this resloping process that the "red" and "black" seams were uncovered at faults that had unstabilized the previous work. These seams were excavated down to El. 6,070, which is 30 ft. below the designed level of the base at El. 6,100. The river bed was at El. 6,140. When this depth was reached it was decided to mine out further soft material from a gallery in the base concrete of the dam since it was essential that concreting be started early in 1937 to prevent further slides as well as to insure finishing the concreting during the 1938 season. Tilt-meters were used at strategic points to give warning of any movements.

**Fig. 2.** Working gallery in the dam. Adits to the red seam are at the right. An air hoist for operating skips on the adit is mounted on the left wall.

The areas exposed under the dam indicated a reasonably sound rock. The last was taken out without blasting by barring and wedging. Borings showed the same material persisted for 50 ft. down. The excavation of the seams and material adjacent to them covered about 30 per cent of the base area below El. 6,100.

### Galleries

The galleries were located with inverts at El. 6,085 paralleling the two seams and offset from them so that the adits would permit the inclined shafts to line up with the top of the exposed seams. Where the black and red seams cross, the black seam appears to pinch out and it is at this point that the galleries intersect.

The adits were spaced on 25-ft. centers and the galleries were enlarged overhead at these points by 2 ft. to make space for the air hoists. Buckets of 5-cu.ft. capacity operating on inclined timber skids dump into 10-cu.ft. dump cars running on a 2-ft. gage track to a skip hoist located in a shaft over the black seam just outside the downstream toe of the dam. It was desired to keep the galleries as small as possible, the size finally being determined by the equipment. The gallery cross section is 6 ft. wide and 8 ft. high. The adits were 7½ ft. wide providing 5½ ft. for the skids and 2 ft. for a ladder and manway. The height, at right angles to the slope, was 5 ft.

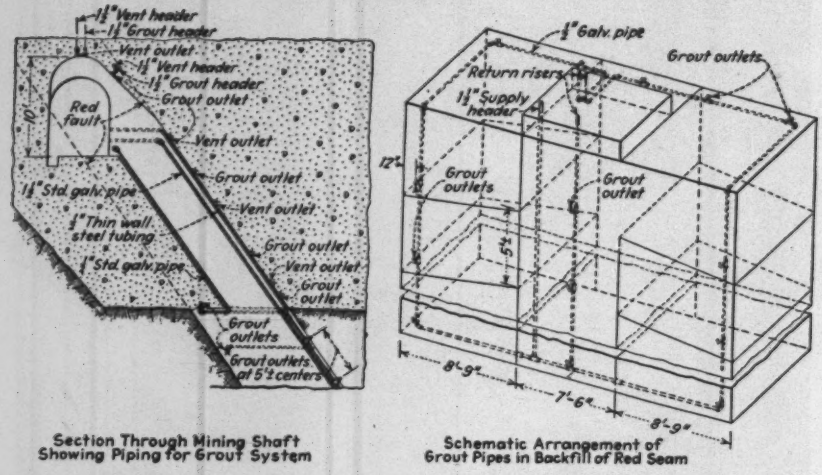



**Fig. 3.** Grouting pipe system for the red seam. A similar system was used for the black seam.

The mining procedure in the red seam was to sink shafts in alternate adits 30 to 40 ft. under the base of the dam. It was found that at such depths the seam had pinched to a thickness of 3 to 4 ft. and it was considered unnecessary to remove the gouge material deeper. The dip of the foot wall was on a flatter slope than the hanging wall. This accounted for the narrowing of the seam.

The second step was drifting from the bottom of the shaft along the seam half way to the adjoining shaft and backfilling this area with concrete. The height of each drift was approximately 8 ft. Concrete was placed only to such a height that the overhanging seam material could be stoped onto the concrete below as the miners moved up to the drifts above on the following day. Timber sets 8x8 in. spaced on 5-ft. centers were placed while sinking the shafts and occasional stulls were set in the drifts depending on the character of the hanging wall. Only such lagging was used as was necessary to protect the workmen from falling rocks. The lagging was removed as the concrete backfill was placed but the majority of the timber sets were left embedded in the concrete.

No explosives were allowed or found necessary as only such material was removed as could be excavated by paving breakers, picks, and shovels. Practically all tools and equipment were air operated, such as paving breakers, sump pumps and hoists.

Concrete was delivered by cableway from the mixing plant to a 4-yd. hopper located above the muck hopper. The same cars used in bringing out muck delivered concrete down the shaft to the gallery level. At the adits the cars dumped into "elephant trunks" chuting the concrete into place where it was vibrated.

The mining procedure in the black seam was altered from that used in the red seam. Due to the steeper dip, crumbly material, and excessive water, it was necessary after the shafts were sunk to move back up under the concrete in the dam and drift along the seam half way to the next shaft and place the concrete in these drifts by bulkheading at the sides of the shaft. The next step was to move a platform down the shaft about 8 ft. and again drift in under the last placed concrete. This plan worked exceedingly well in the 5-ft. black seam and allowed the removal of practically all timber as the shaft was later filled with concrete.

For localities where it was impossible to use elephant trunks, a specially designed gun was used to blow the concrete into place.

The draining and unwatering of the seams was simplified by the sinking of the deepest black seam adit in advance of most of the excavation. Electric pumps in this sump held the water table to a point where practically all work was accomplished in a semi-dry state.

It was found in sinking the black seam shafts that the seam was offset about 20 ft. at the foot wall of the red seam so all disintegrated material was removed to the 50-deg. sloping foot wall of the red seam resulting in a triangular block of concrete backfill about 10 ft. deep at the axis of the dam and 87 ft. deep at the downstream toe.

To provide a suitable cut off in the red seam under both abutments the red seam gallery was extended in 10-ft. sections by mining methods, setting 7-ft. diameter forms with the back end bulkheaded, and pumping in the concrete through 8-in. dia. pipe set in the arch forms. This concrete was vibrated until the workmen had to get out of the forms so the arch could be blown. By the above procedure the circular tunnels were advanced 80 ft. under the left abutment and 50 ft. under the right abutment. These tunnels were ring-drilled at 10-ft. centers with three holes each in the hanging wall and three in the foot wall and then grouted.

Grouting systems were installed on the hanging wall of both red and black seams previous to backfilling with concrete. These grouting systems have just been filled successfully with a grout of 1.0 water cement ratio. A total of 4,000 sacks of cement were pumped into the lines with pressures varying from 150 to 250 pounds per sq. in.

By the employment of competent foremen and experienced miners and timbermen approximately 3,500 cu. yd. of seam material was removed and concrete backfill placed without a single mishap causing injury or loss of time. This work starting in July was carried on continuously for five months, three shifts a day, with an average of 14 men to a shift. Concrete placing on the dam was completed in November, the parapets being finished six weeks previous to the last placement of concrete in the foundation.

In March, 1939, with water storage in the reservoir 125 ft. deep above the galleries, the flow through the gallery drain holes drilled subsequent to grouting is only 5 gal. per min.

The Kendrick project is being built by the U. S. Bureau of Reclamation of which John C. Page is commissioner, R. F. Walter, chief engineer and J. L. Savage, chief designing engineer. On the project are H. W. Bashore, construction engineer, I. J. Matthews, office engineer and J. H. Warner, resident engineer in charge of Seminoe Dam. Morrison-Utah-Winston-Lawler are the contractors for the Seminoe Dam with Winston Brothers Co. as the directing agency at the dam.

FIG. 1. LONG PARABOLIC CURVES TYPIFY "GRADE LOCATION".

# Abney Level in Road Surveys

STUART D. LONG

Civil Engineer, Grand Rapids, Mich.

*Abney level highway location method, developed by U. S. Forest Service, proves fast and inexpensive on private roads*

IN THE BUILDING of private roads to facilitate travel to construction jobs, hand level locations make an important bid to lower costs and give quick surveys. Especially is this true in rough mountainous country where roads are used only during the construction period and subsequently abandoned.

During the past ten years the United States Forest Service has used for its truck trails a type of location survey which is essentially a hand level method. Its practicability has been shown and its position as the fastest and most inexpensive type of survey is well established. Hand levels have been used in road work more or less for years. The idea in this method is not new; merely an expansion of an old one.

### Abney level

The first step in the development is to replace the straight hand level with an Abney level. This instrument is fundamentally a hand level with the level tube mounted on a movable arm which may be set on a scale graduated in per cent of grade. The level bubble moves in a plane perpendicular to the horizontal and parallel to the line of sight. The markings of the graduated scale indicate the vertical angle of the line of sight in per cent of grade.

Where it is desired to gain elevation, as on a road from a river bottom to a plateau, the best-designed road will be one of constant grade. With the Abney level it is possible to run a grade line out on the ground (with neither cut nor fill at the station) by setting the scale at the given grade and producing that grade by reading the personal H.I. at each station. This is the most important feature of the method, for it is at once seen that the distance from the instrument to the station is of no prime importance in determining the grade at that station. This feature is desired when location work runs in heavy brush country where sight distances vary with each reading.

### Grade location

To utilize this grade point instead of the centerline point, a rather good plan has been worked out by the United States Forest Service. In substance it is as follows: It will be assumed that a grade contour line (the writer's term for an imaginary line which follows plus or minus grade along the existing earth surface) has been staked out on the ground at 50-ft. stations. The stake now set is on the grade of the section and not on the centerline. Referring to Fig. 2, we see the balanced section, so-called from the fact that all of the cut in the section is required to make the fill in the section. The stake set when running a grade location is at $G$ in the sketch and, it will be noted, is some distance from the centerline of the section. This distance varies with the slope of the section and approaches the left hand edge of the section as the slope approaches the natural angle of repose of the material.

Now if the cut bank has a back slope of $\frac{1}{2}$:1 (decomposed granite and stable materials), and the fill has a slope of $1\frac{1}{2}$:1, and the cross section angle $S$ is known, it is possible to set up equations for the end areas of cut and fill as follows:

$$A = \frac{a^2}{2 \cot S - 1} \text{ and } A' = \frac{(w-a)^2}{2 \cot S - 3}$$

These formulas may be solved for various values of $S$ by approximating a value for $a$; and if $A$ is equated to $A'$ (balanced section, cut equals the fill) then $V$ is found to equal $1{,}852A$ for 50-ft. sections. And the distance from the grade stake up the slope to the cut stake is $x = 2A/a \sin S$.

Therefore with tables computed for

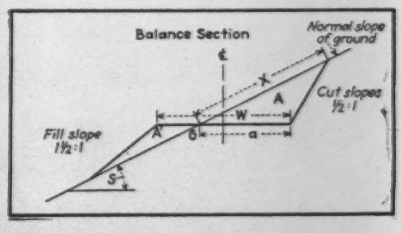



**Fig. 2.** Balanced sidehill earthwork section which is desirable in roads located with the Abney level.

various values of road width, cut and fill slopes, and cross section angle it becomes a simple matter to locate a stake on the grade of the section, tape the distance $x$ up the slope and locate the cut stake. A part of such a table prepared by the United States Forest Service is shown in Table 1. The cross section angle $S$ is measured at the station or at a point considered to be the average for the station. This is done with an inclinometer or slope rule. The distance from the grade stake to the heel of the cut is given under $a$. A use for this will be shown later. The distance from the grade stake to the cut stake measured up the slope of the ground is $x$. Under $V$ is the volume of the section in cut for a 50-ft. section, used only for cost accounts and estimates of total yardage involved. With these tables the survey moves very rapidly. The grade stakes are set with the Abney level, and have neither cut nor fill; the slope stakes are set by taking the cross section slope angle and determining the distance up the slope from the tables; and the cut on the slope stake is determined by rod readings directly from grade. It was the writer's experience that when cross section slope angles were intelligently taken splendid results were obtained in yardage balance when proper road width and grade were reached.

As would be expected the road resulting from this type of location survey is sinuous in nature since the grade points are located without respect to alignment. The resulting grade contour curves are, however, parabolic in nature and give good driving easement as may be seen from Figs. 1 and 3.

Since this grade method produces a sinuous road it would be expected that in some cases short through cuts and fills would materially straighten out a location through country cut up by many short ridges and draws. In like manner when the location approaches a deep gulch the grade contour will produce a hairpin curve. In these two instances the location must be changed from the grade method to the conventional centerline method.

To make this change from grade to centerline it must first be determined at what station the location is to leave grade and enter upon centerline. Fig. 4 is a graphic representation of a grade contour replaced by a centerline location giving a through cut and fill. The location has been progressing on grade from the right hand side and has been ended at station $A$, the point chosen as suitable for entering upon centerline location. At this station must be determined the centerline of the section. Referring to Fig. 2, it is clear that the centerline

TABLE I — BALANCED SECTION SLOPE STAKES AND VOLUMES

Width of Road 16 ft.
Cut slope ¾:1 Fill slope 1½:1

BALANCED EXCAVATION TABLE

| $S$ | $x$ | $V$ | $a$ |
|---|---|---|---|
| 10 | 9.4 | 12.9 | 8.4 |
| 11 | 9.6 | 14.6 | 8.4 |
| 12 | 9.8 | 16.3 | 8.5 |
| 13 | 9.9 | 18.2 | 8.6 |
| 14 | 10.2 | 20.2 | 8.7 |
| 15 | 10.5 | 22.2 | 8.7 |
| 16 | 10.7 | 24.1 | 8.8 |
| 17 | 11.0 | 26.4 | 8.9 |
| 18 | 11.3 | 28.9 | 9.0 |
| 19 | 11.6 | 31.7 | 9.1 |
| 20 | 11.9 | 34.6 | 9.2 |
| 21 | 12.3 | 37.9 | 9.3 |
| 22 | 12.7 | 41.4 | 9.4 |
| 23 | 13.1 | 45.3 | 9.5 |
| 24 | 13.6 | 49.6 | 9.7 |
| 25 | 14.2 | 54.5 | 9.8 |
| 26 | 14.7 | 60.0 | 10.0 |
| 27 | 15.4 | 66.4 | 10.2 |
| 28 | 16.2 | 73.8 | 10.5 |

$S$ is the cross section slope angle in degrees
$x$ is the distance measured up the slope from the grade stake to the cut stake
$V$ is the volume in cu. yds. per 50 foot section
$a$ is the width of the road bed in the solid

Fig. 3. A piece of road location which utilizes the balanced section.

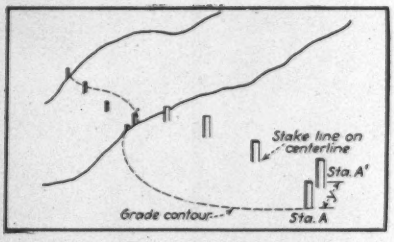



Fig. 4. Diagram showing conversion from grade line to centerline location.

may be established by measuring from $G$ a distance equal to $(a—w/2)$ with $a$ being found in the tables. This is the distance $y$ in the sketch and station $A'$ is then on the centerline of the section. From $A'$ to the point where the location is to return to grade the work is carried on in the conventional centerline manner. The station stakes are then set in line and elevations run with the Abney level set at zero per cent of grade and used as a hand level. At the final station the reverse process is done to determine the grade point, or it may be done by computing the grade rod at that point and setting the rod until the grade rod is read.

Yardage for the cut and fill section must of course balance. Since in most cases the grade is predetermined (ruling grade) and should not be changed, any discrepancy in the yardage balance should be adjusted by a change in location rather than in a grade change. It was the writer's experience that if the centerline cuts exceeded the centerline fills by 1½, the location was close enough to make a determination of the yardage. Tables for centerline cuts and fills may be evolved similar to those for balanced section and readily give volumes for 50-ft. sections when road width, centerline cut or fill, and cross section slope angle are known. Cut stakes are set in the conventional "cut and try" manner.

## Conclusion

While present day trends are leading to more exacting surveys in all fields so must the trends for lower classes of roads progress. Certainly the method used by the United States Forest Service has done this. With grades run to an accuracy of tenths the yardage computations are far from accurate enough to be used on anything but private road jobs. For speed it is unequaled. The writer has gone into country where only a rough

reconnaissance survey has been run to determine the practicability of reaching control points at ruling grades, made a complete Abney level survey, and has 1,200 ft. of road ready for the blade by night. The method eliminates all office work by making the few necessary yardage computations in the field. Profiles are used only for total yardage and construction conditions for office records. Yardage placement is always quite obvious in the field.

Costs of such surveys as prepared by C. L. Young, chief surveyor of Region Five, United States Forest Service, show some interesting details.

| | |
|---|---|
| Easy country, slopes under 30 deg. | $75 per mi. |
| Average heavy timber | 150 per mi. |
| Dense brush and heavy slopes | 275 per mi. |

These costs cover all of the locators' time on the job including loss of time due to bad weather, traversing the completed road and preparing maps and records.

This material first appeared in a thesis for graduate degree, Michigan State College, 1937. Tables are for sale by the Superintendent of Documents, Washington, D. C.

# Unfair Prices For Extra Work

***Contents in Brief—An engineer-contractor with twenty-five years' experience in building and heavy construction finds that engineers commonly penalize the contractor in specifying prices for extra work. As in the previous article, ENR March 16, p. 53, the author remains anonymous.***

IN HANDLING extra work on buildings, the general conditions of the American Institute of Architects specify three methods of payment: lump sum, unit price, and cost and percentage or cost and fixed fee. There is no attempt to set up unreasonable compensation for extra work as is done by many engineers. Quoting from a recent specification:

> If no unit prices or lump sum prices are agreed upon, the contractor shall be paid the net cost of materials and labor and workmen's compensation insurance plus 10 per cent plus such rental for equipment and plant as may be required and approved, which 10 per cent shall be compensation for all other items of profit and expense and cost, including overhead, superintendent, insurance, materials used in temporary structures, allowances made by the contractor to subcontractors, bond premium and the use of tools.

If the engineer intended that the contractor should do extra work at a reasonable profit, he certainly made a mistake in writing this paragraph. The contractor is supposed to be qualified and experienced and well financed. His general-office overhead even in good years will not be much less than 5 per cent. His field-office cost prorated over the cost of labor and materials for any job will run in the neighborhood of 5 per cent. The cost of tools will be 2 to 3 per cent of labor and often up to 5 per cent. Public liability and property damage insurance will run to 1½ to 2 per cent of the payroll, social security taxes to 4 per cent of the payroll and bond premium to 1½ per cent of the amount received for the extra work.

Let us use an example and see how the contractor fares under this arrangement. Let us assume his extra work amounts to $500 split half labor and half material: Material $250, labor $250; workmen's compensation insurance, say 8 per cent of labor, $20; public liability and property insurance 1½ per cent of labor, $3.75; social security taxes 4 per cent of labor, $10; tools 2 per cent of labor, $4; office at works 5 per cent of $500, $25; bond 1½ per cent of the amount of the extra (in this case $572), $8.58, and total, $571.33. The amount received leaves a margin of 67c for general overhead, use of capital, profit and sometimes a year's guarantee thrown in for good measure.

Assume now the job was mostly labor, say digging a trench with sheeting required. Labor cost is say $500, workmen's compensation insurance $40 and total payment $594. The contractor has received a "profit" of $54. Public-liability and property-damage insurance cost him $7.50, social security taxes $20, tools $10, office at works $25, and bond $8.91, total $61.41. In addition he has had to contribute the use of several thousand feet of lumber for sheeting for which he got nothing.

If engineers desire to do business with responsible contractors, they minimize the possibility by such provisions of payment. They are unfair to the industry which does their work. They are drawing a harder bargain than a fair-minded owner would ever ask.

To be constructive, it might be well to suggest a paragraph to replace the one given above. It would read something like the following:

> If no lump sum or unit prices are agreed upon, the contractor shall be paid for the work on the basis of cost plus 15 per cent for extra items under $1,000 and cost plus 10 per cent for extra items over $1,000 each. Cost shall include a reasonable allowance for use of tools, rental of equipment and use of temporary materials and the cost of bond and insurance, and of all taxes paid on the amount of the payroll, on the materials or on the gross revenue of business. The cost of the work shall include the payments made to subcontractors, when permission has been given to sublet any portion of the work, and a fair share of the cost of supervisory and clerical employees at the job office.

It has often happened that where extra work is to be paid for at cost of net labor and material and compensation insurance plus 10 per cent, such extra work consisted of plastering, plumbing or electrical work which had been sublet by the general contractor. The general contractor only sublets such work because in the long run the subcontractor can do the work cheaper than he could. He is glad to pay 10 per cent overhead plus 10 per cent profit or more rather than increase his own overhead a like or greater amount by enlarging his organization and buying the necessary equipment to handle those branches. Still he cannot sublet items of extra work even at the price the engineer has set up as total payment. He is forced either to sublet the work at a loss to himself or to hire men and start business in a specialized line against his will. Such a result is not desirable unless engineers wish definitely to reform the whole industry and to eliminate subcontractors entirely from the work which they design. Some thought should be taken before making such a change.

# Grouted Ballast Slabs for Track Support

***Contents in Brief—Pennsylvania R. R. makes a trial installation of cement-grouted slabs as a support for heavily traveled track in a section where soft ground makes constant surfacing necessary. Two methods of construction studied to develop most economical system.***

TWO TEST SECTIONS of sub-ballast slab built by the cement-grouting method used in highway and street pavement construction were laid last fall by the Pennsylvania R.R. in cooperation with the Portland Cement Association. Before winter set in, more than 800 ft. of slab 10 ft. wide and 12 in. thick had been laid under soft track adjacent to Bedford Yards, about 9 miles southeast of Cleveland. Traffic over this section of the main track is heavy, including both ore and coal shipments, high-speed freight and numerous passenger trains, some operating at speeds around 70 m.p.h. The underlying material is a blue clay which is in a saturated condition most of the time due to high groundwater. Correction of the line and surface heretofore was required about twice a week and lifts of about 2 in. in the track have had to be made at frequent intervals.

The possibilities of supporting track on concrete slabs where ground conditions are bad have been studied by railroads for a number of years, but the apparent high cost has prevented many test installations. Last year the Missouri Pacific completed a test installation of about a mile of precast concrete slab (*ENR*, July 28, 1938, p. 105); the present work on the Pennsylvania R.R. introduces a new type for study.

For the first 600-ft. section of the slab built by the Pennsylvania, traffic was diverted to an adjoining track, the rail and ties and ballast were removed, and the underlying clay was dug out to a depth of about 2 ft. below the bottom of the ties, no effort being made to grade the bottom accurately. Side forms 12 in. deep were set as the work progressed and stone for the slab was unloaded from gondolas on an adjoining track. The stone was standard crushed ballast ranging in size from 1¼ to 2½ in. Laborers spread it to a 1-in. crown at the center of the track and two men using a 12x12-in. oak tamper compacted it ready for grouting.

The mixer train operated on two parallel tracks adjoining the working point. On the first track were four sand cars, two on either side of a flat car holding the two mixers. With these five cars was an air-compressor car and two locomotive cranes. On the parallel tracks were two box cars containing cement so secured to the mixer car that the entire set-up could be moved along by the locomotive crane as grouting progressed.

**Fig. 1. Placing and spreading crushed stone for the grouted track slab.**

Grout was mixed in two 10-S mixers so set that their discharge spouts emptied into a central tank of 38 cu.ft. capacity containing an air-operated paddle agitator which kept the grout thoroughly mixed. From this hopper tank grout was fed by gravity through 50 ft. of 2½-in. fire hose to the working point. All equipment for the work was taken from regular equipment in use on the railroad.

The consistency of the grout, as measured by a flow cone, was maintained at 21 sec. The mix required to produce this consistency was three sacks of cement, 600 lb. of damp sand containing 5 per cent of surface moisture by weight, or 3½ gal. of free water, and 21 gal. of added water. This produced a water-cement ratio of 8.2 gal. per sack of cement. Each sack produced about 8 cu.ft. of grout.

Beginning at the high end of the work, grout was distributed by one man at the nozzle of the hose and two men with warehouse brooms brushing excess grout ahead or into voids. Grouting progressed at the rate of about 1.1 ft. per min. Observations made through holes dug down through the rock ahead of the grouting indicated that the grout ran forward along the subgrade about 4 ft. ahead of the hose.

The grouted stone was given a second compacting with the oak tamper, but no effort was made to produce a finished surface as the roughness of the projecting stone was considered advantageous in retaining ballast on the slab.

The grouting crew consisted of 16 laborers and a foreman from an extra gang, 7 men and a foreman from a bridge and building gang, and one compressor operator.

The work was carried on in November. On the first day the track connections to vacate the test sections were made and the track was removed. On the second day rain followed by snow delayed the work but excavation was started, using

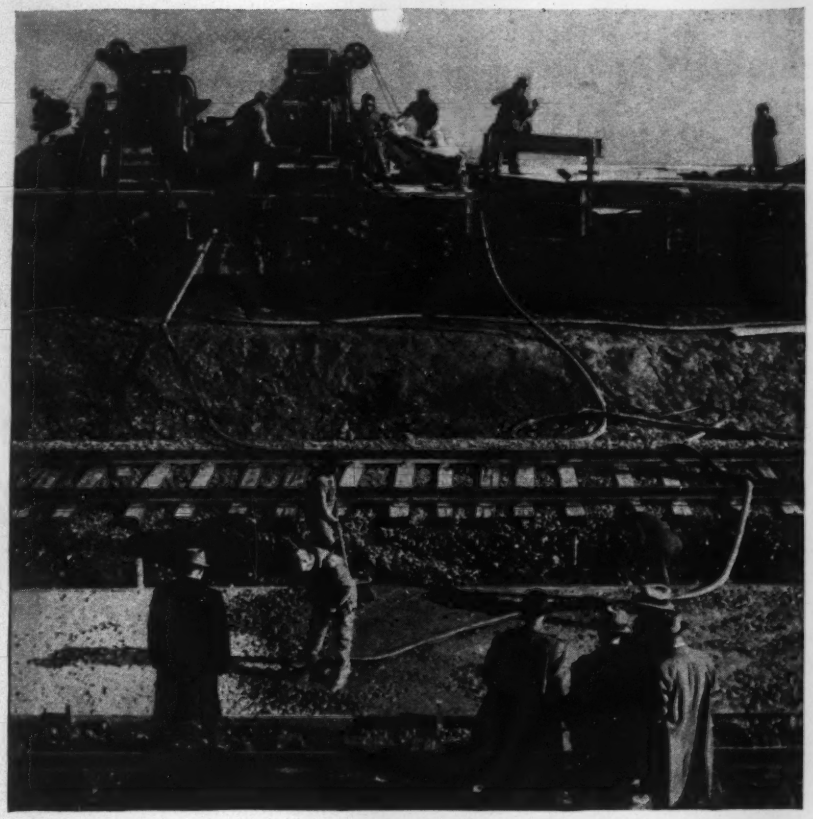


Fig. 2. Grout was mixed in twin mixers mounted on a flat car and was supplied to the work by gravity through 2½-in. fire hose.

four crawler cranes with ¾-yd. buckets mounted on gondolas to dig out the old ballast and load it into empty gondolas. Due both to bad weather and hard digging in the tough mixture of ballast and clay the work took 21 work-train hours spread over three days instead of one day of two 8-hr. shifts, as planned. Unloading and placing the stone took 6½ hr. on the second day. Grouting started on the morning of the fifth day and required 10 hr.

Replacing the track started on the third day after grouting. Ties were placed directly on the slab and the rail which had been disconnected and drawn back in a single length at each side, was moved into place again and connected. Clean ballast was then spread over the track and the track jacked up for a 12-in. lift and surfaced. Ten days after the slab had been grouted the track was put in service for limited speeds but all slow orders were removed within a few days.

For the second operation the work was planned to be carried out without taking the track out of service, sections of track about two rail lengths long being rebuilt in a 7-hour period during which traffic was routed over other tracks. The excavation was done with steam cranes operating on an adjoining yard track.

Here again, the nature of the material made the digging so slow that the projected 7-hr. period was overrun the first day. This difficulty was overcome on the second and third sections by dynamiting the top crust of the old ballast.

As soon as men could work in the excavated area, the subgrade was leveled and forms were set. Two clamshells operating from an adjoining yard track dropped the stone for the slab from a considerable height onto the subgrade. This stone was spread to a 1-in. crown but was not tamped as in the earlier work.

Grouting methods were identical except that the consistency of the grout was increased to produce a flow of from 23 to 24 sec. This proved to be more satisfactory and it is planned to use this consistency for future work.

As soon as from 10 to 12 ft. of stone had been grouted, ballast was dropped on top of it and leveled off to a thickness of 12 in. Track was replaced as soon as all the ballast had been spread and was put back into service in about seven hours after the start of work. Three sections were rebuilt in this way before bad weather made it necessary to shut down the work for the winter.

In construction of the second section of the slab, surface water from rain on the previous day stood in pools on the subgrade and as grouting proceeded, accumulated against the bulkhead at the lower end. Though a pump was used the time limit on operations made it necessary to grout into stone filled with water to the top of the forms. When the end of the slab was uncovered days later, as shown in Fig. 3, no sign of ill effect was found.

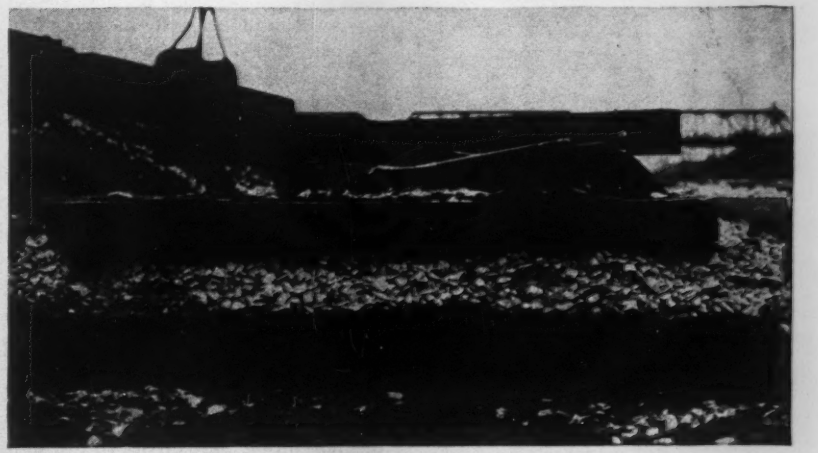


Fig. 3. End of a section of track supported on a grouted slab. Trains operated over this slab within two hours after the grout had been placed.

# Structural Adobe

L. T. EVANS
Structural Engineer, Long Beach, Calif.

***Research indicates modern machine-made product has qualities, including uniformity, that make it an engineering material***

RECENTLY there has been a revival of interest in the use of adobe in the southwestern part of the United States. Although adobe structures have been used in this region for many years, such improvement has been made in the process of manufacturing the blocks that the structural adobe of today is a building material that may be designed with reasonable accuracy. There is little in common between the modern waterproof blocks made by machine and the early blocks made by hand of mud and straw.

Since the Southern California earthquake of March, 1933, the writer has built a laboratory for the sole purpose of privately investigating the true behavior of structural materials. The experiments are covering the questions of actual stress distribution in materials and also the effect of the shape of the finished structure. One of the materials investigated was a high grade machine-made structural adobe that exhibited good uniformity and consistent structural properties.

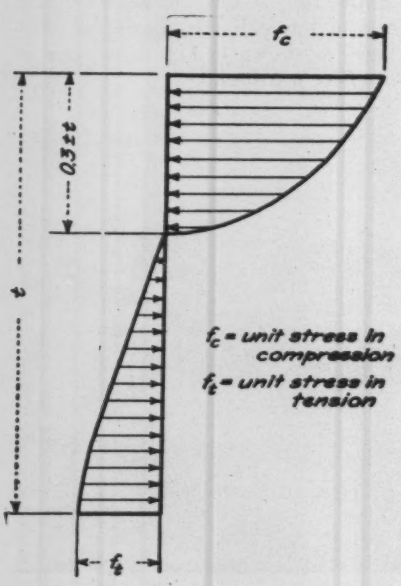



**Fig. 1.** Typical stress distribution across a rectangular section of adobe.

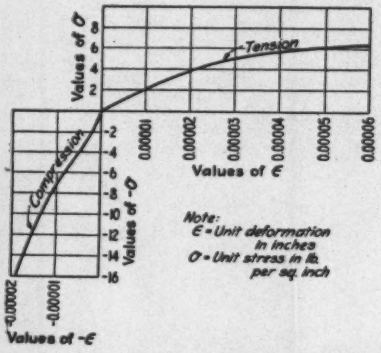



**Fig. 2.** Typical stress-strain curve for square adobe section.

The series of adobe tests were divided into three main parts. The first portion of the tests was made upon beams, struts and columns of material 28 days old. The columns were taken of various lengths so as to study the effect of "long columns." Specimens were tested in pure compression, in compression combined with moment, in pure tension and in tension combined with moment and in shear. Some pieces were tested by a continuous application of the load, most of the remainder were tested by allowing a constant time interval between increments of load, and a few were loaded to approximately half of their ultimate capacity, the load then held constant, and time-distortion readings taken.

The second and third portions of the tests will be made when the material is two years old. Part of this future work will be made upon identical pieces as used for the first part so as to study the effect of age, while the remaining part of the future tests will cover the effect of stress concentrations caused by holes in models of walls, etc. These holes represent various combinations of windows and doors in walls of buildings that are stressed by earthquake forces.

The results of the tests already made may be briefly summarized as follows:

1. The structural adobe was a semi-plastic material.
2. Average ultimate unit stresses were:
   (a) Compression: 500 lb. per sq.in.
   (b) Tension: 60 lb. per sq.in.
   (c) Shear: 60 lb. per sq.in.
3. Stress distribution across a rectangular section was not linear, but followed a curve somewhat as shown in Fig. 1.
4. The modulus of elasticity of the material in tension differed from that of the material in compression, and each was a function of the unit stress. Fig. 2 shows a typcial stress-strain curve for a prism of square cross section.
5. Tests for Poisson's ratio were not uniform, but the average value obtained was approximately 0.4. This value will be reinvestigated as it does not agree with the other data found.

Using the results of the direct load tests, charts were computed and constructed showing the effective modulus of elasticity for a particular section. The charts also give the unit stresses for given values of moment and direct load. The results from the charts were then checked by data obtained from the tests of specimens subjected to direct compression and lateral bending moment. In as much as most applications of adobe will require information as to its action under compression and moment, the chart given will be found useful for investigating small residential structures.

The following numerical example will illustrate the use of the chart for a section of width $b$, 12 in., depth $d$, 18 in. deep subjected to a compressive force $N$ of 400 lb. and a bending moment $M$ of 4,000 in lb.

$$E = \frac{M}{N} = 10 \text{ in. and } \frac{E}{t} = \frac{10}{18} = 0.55$$

From the small auxiliary chart in the upper right hand corner of the main chart, the value of $\frac{e}{t}$ corresponding to $\frac{E}{t} = 0.55$ is 0.40. Entering the main chart with the value of $\frac{e}{t} = 0.4$ and moving horizontally to the right to the intersection with the curved line, thence reading downward to intersect the curved lines labeled "compression" and "ten-

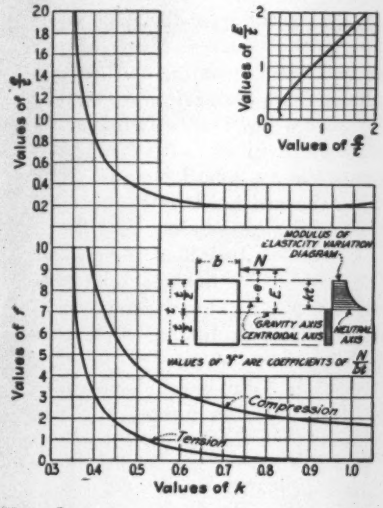



**Fig. 3.** Design chart relating modulus of elasticity to unit stresses for given loads and moments.

sion," and moving again to the left to find the corresponding unit stress as a coefficient of $\frac{N}{b\ t}$ :

$$f\ (\text{compression}) = 4.75 \times \frac{N}{b\ t} =$$

$$4.75 \times \frac{400}{12 \times 18} = 8.8 \text{ lb. per sq. in.}$$

$$f\ (\text{tension}) = 1.25 \times \frac{N}{b\ t} =$$

$$1.25 \times \frac{400}{12 \times 18} = 2.3 \text{ lb. per sq. in.}$$

The unit stresses covered by the chart will be found sufficient for practically all cases encountered. It may be seen, however, that the unit stress in tension is very small with respect to the compressive unit stress. This is fortunate as it is in keeping with the respective ultimate unit stresses. If we were to assume a factor of safety of, say 15, so as to provide for some carelessness in the construction of the adobe building, we still have an allowable working stress of about 33 lb. per sq. in. in compression and about 4 lb. per sq. in. in shear or tension. From study of structures, it has been found that these allowable unit stresses are never exceeded for 0.1 *g* computations, except for unusual conditions.

It is also significant that measured deflections on cantilever and simply-supported beams checked very closely with computed values when the "effective" modulus of elasticity was used. Because of this, the writer feels that structural adobe can be designed to withstand seismic loads.

# Putting a 15-mi. Flume Underground

*After 30 years of service a timber flume supplying a water-power plant on the Stanislaus River is being replaced by an 11-mile tunnel*

ON THE SOUTH FORK of the Stanislaus River in California a timber flume 9x6½ ft. in section has been in use for some 30 years serving a water-power plant of the Pacific Gas & Electric Co. As the flume has aged, maintenance requirements have increased until recently 1,500,000 ft. b.m. of lumber has been required annually to keep it in repair. It was therefore decided that the flume should be replaced by a tunnel. The carrying charge on the tunnel, whose total cost is estimated at $1,800,000, is expected to be less than flume maintenance. In addition there will be the advantage of avoiding interruptions to power generation that have occurred frequently in wet-weather periods when landslides took out sections of the flume. Tangible savings resultant from "putting the flume underground" are estimated at $33,000 per annum.

**Fig. 1.** For 15 mi. this flume skirts the Stanislaus canyon. Note track laid on the flume.

### Stage construction for tunnel

The tunnel, which is only 11 mi. in length as compared to the 15.5-mi. flume route, is being constructed in successive steps or sections beginning at the lower end. Three separate portions of the tunnel, 3.3, 3.7 and 4 mi. long respectively, will be completed successively and each will be put in service as soon as finished. The first section was finished early in 1938 and has been in service since that time.

Work started late in 1936 and the entire tunnel project is to be completed by 1940. The successive-stage plan of construction permits the use of a relatively small construction force which moves from camp to camp as work progresses. The camp buildings are sectional structures moved to successive locations as required. The tunnel will be unlined because the required capacity of 390 sec.-ft. will be passed easily by an

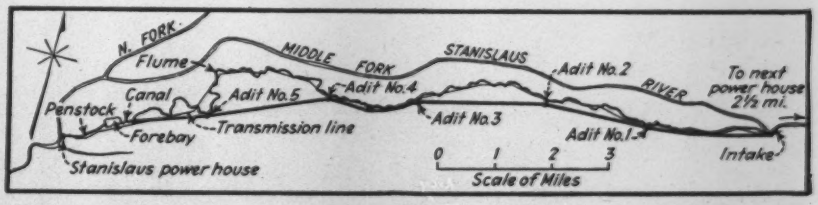



**Fig. 2.** Relative location of flume and tunnel between two Stanislaus River water-power plants in California.

unlined 9½x10 2/3-ft. section, the minimum size that permits the use of standard construction equipment without change.

Thus far the tunnel, which follows the slope of the canyon wall rather closely, has been in solid granite and grano-diorite which requires no timbering. The location was selected with a view to short adits at locations convenient for camp construction and where buildings could be placed close to the flume. No roads have been built into this region and because a light railroad is maintained on top of the flume it was not felt necessary to build construction roads to the several camps.

The work has been done under the general direction of O. W. Peterson, engineer of general constructions; Hector Keesling is assistant engineer. At the headquarters camp J. E. Cooney is in charge of construction and Harry F. Scott is tunnel superintendent.

# Light Narrow-Gage Railway Serves Big Construction Job

***Light track laid on a wood flume shows long service and low maintenance despite sharp curvature and continuous tension in the rails***

A RAILROAD of 36-in. gage was laid on top of the timber flume described in the preceding article when that flume was built 30 years ago. When the track was laid the intention was to use it for hand cars only, but about 5 years later need for moving a considerable tonnage of materials arose and small locomotives began to be used for hauling freight over the line. Recently the line was required to handle 7,600 tons of equipment needed in driving an 11-mi. tunnel to replace the flume. At the same time some 2,800 tons of material have had to be moved annually over the railroad for use in repairs and renewals of the flume itself.

The railroad is extremely tortuous, numerous curves have radii as short as 40 ft. and one has a 28-ft. radius. In its length of 15.5 mi. there is a total of 18,000 deg. of curvature. Despite this there has been a very small amount of rail renewal, and derailments have been rare. The successful operating record is ascribed in part to the careful design of the cast-steel wheels used on the rolling stock. These wheels are 18 in. in diameter at gage, have a 4¼-in. width of tread and a 1¼-in. flange height. The tread tapers ½ in. in its width which gives a tendency to pull the weight away from the flanges on the outside of curves. Much of the wear and all "squealing" of wheels resultant from the grinding on the sharp curves has been eliminated by a constant drip of water from the locomotives to wheel treads, thus keeping the rail head well moistened while wheels are passing over it.

The ordinary trainload for a 3-car train is 6 tons: normal operating speed is 6 m.p.h. The maximum concentrated load is limited to 4 tons and the weights of single pieces of construction equipment have been kept down to this figure. For this maximum load a special rig combining two flat cars is used: it includes a bolster in the center of each car so that the weight is distributed over 4 axles in a length of 34 ft. Because of the very slight grade in the flume (about 0.001 per cent) the tractive effort required has not been great.

The largest item of track maintenance has been the replacement of the 2x12-in. planks to which the rails are spiked. In eight months of 1938, 6,944 lin.ft. of these planks were renewed.

A curious phenomenon observed on this track is the constant lengthening of flume and railroad resulting from centrifugal force of the water pushing the flume outward on curves.

TYPICAL MOTOR UNITS FOR FLUME RAILROAD

| Make | Weight (pounds) | Type of drive | Rigid Wheel Base (inches) |
|---|---|---|---|
| Prescott tractor with Ford Model B motor | 2,800 | worm | 45 |
| Whitcomb tractor with 25 hp. Continental motor | 3,310 | chain | 42 |
| Two Ford Model A speeders | 2,000 | chain | 48 |
| 1 F. M. Sheffield 40 speeder | 1,250 | chain | 40 |
| 1 Buda 120 motor car | 420 | chain | 35 |

This movement puts tension in the rails which eventually breaks splice plates, pulls the ends of the rails apart and makes it necessary to fill in the gaps with short pieces of rail. In a 2,300-ft. track length on which careful record was kept, 15 of these inserts have been used with a combined length of 36 in. If this is taken as representative, the total length of the flume now would be found to be about 100 ft. longer than when it was constructed.

Operation of the flume has been under the general direction of O. W. Peterson, engineer of general construction, Pacific Gas & Electric Co.; J. E. Cooney is superintendent on the Stanislaus project, which includes the flume railroad.

Locomotives assembled on the job haul trains over a 36-in. track using 12-lb. rails.

# Selling Water to the Public

***How a water company keeps satisfactory relations with its customers through an educational program followed by maintenance of a quality product and service***

IN ITS CAMPAIGN to inform its customers of the pertinent facts concerning its system and product, the Indianapolis Water Co. uses all of the modern types of publicity available to any other commercial enterprise. Newspaper advertising, outdoor advertising boards, entrance signs that bid a welcome to visitors at the water treatment plant and principal pumping stations, pamphlets, folders, calendars, blotters and other forms of printed material delivered by meter readers and motion pictures in both natural color and in black-and-white are some of the publicity avenues by which the company endeavors to reach its customers day by day.

The movies, one entitled "Behind the Water Front," and the other entitled "Water Colors," have been shown about 450 times. A shorter film "Water at Home and Abroad" is in the nature of a travelogue.

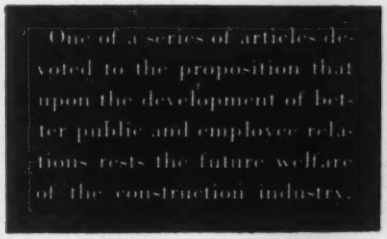
Exhibits of various kinds also are included in the material used for publicity purposes. Relief maps of the watershed area, model homes with water pipes and plumbing clearly shown and an electric map of the underground distribution system are displayed around the city and in the lobby of the company's office from time to time.

"What John Told Mary's Neighbors" a chatty 16-p. 4½x6½-in. booklet, recounts a newlywed's conversation to a group of neighbors about the source, distribution system, water treatment and other facts about the city's water supply. Homely examples of chemical reactions abound.

"Paint Your Lawn Green" is a compendium of expert advice on how best to water a lawn, what it costs, weed control, fertilizers, lawn seed, trees, and finally a quotation from a survey made by the University of Illinois on the wholesome effect of good lawns and landscaping on sales of homes.

Another leaflet gives the results of a residential occupancy survey, not including apartments, made by the company through its meter readers. This leaflet is eagerly sought by real estate and rental agencies and is given wide publicity by local newspapers.

Blotters are used frequently. One of the most popular shows in graphic


One of a series of articles devoted to the proposition that upon the development of better public and employee relations rests the future welfare of the construction industry.

form the cost of leaks and boldly says "Satisfied customers are worth more to us than revenue secured from water uselessly passing through our meters." In fact, the message of "Don't Ignore Leaks" appears frequently in the company's printed material.

"Water Service" is a beautiful 48-p., 6x9-in. illustrated brochure on coated paper with blue cover pages. It includes such topics as the development of public water supplies in the United States, progress in Indianapolis, sources, water treatment and filtration processes, pressure and pumping, distribution, fire protection, uses of water, rates and revenue and water as an essential commodity to the domestic and industrial life of the city. It ends by saying, "Water may come from the heavens, but it travels a long road from there to your faucet and many hands contribute to your service in furnishing you with fresh, clear and safe water." An interesting sidelight on this booklet is its popularity as a civics textbook for pupils in the higher grades.

Publicity and advertising, says the company's manager, is but one step in the public relations program. Several years ago the company deliberately did away with its so-called public relations department. It works on the theory that every employee has his public relations function in carrying through on his everyday duties and spreads that doctrine throughout the organization. Satisfactory relations with customers depend basically on the quality of the product and the service which is rendered to the customer by every man in the organization. To keep every individual employed by the company alive to the need of maintaining good relations with the public is not the least important duty of the manager and his aides. The company's publicity program is designed to stimulate customer appreciation of this service.

**Messages on five billboards at Indianapolis are changed once or twice a year.**

# Tunnel Paved with Concrete Blocks

***Contents in Brief—Precast concrete blocks, 4 in. thick and 12 in. square, form a new type of tunnel pavement in the Manhattan underground approach to the George Washington Bridge in New York City, now being completed to accommodate the coming World's Fair traffic. The blocks are laid in fast time on a bituminous mastic cushion; joints are poured asphalt.***

A NEW TYPE of tunnel pavement in the form of precast concrete blocks is being installed in the 178th St. underground vehicle approach to the George Washington Bridge in New York. The blocks, each 11¾ in. square and 4 in. thick, are laid with poured asphalt joints on a bituminous mastic cushion. The paving, being laid in the 2,350-ft. cut-and-cover tunnel cutting across the upper end of Manhattan, is part of The Port of New York Authority's current program of extending the New York approach facilities, curtailed at the time the bridge was opened in 1931 pending increased traffic. Though the tunnel structure was built several years ago, it was never finished for use. Anticipated World's Fair traffic this year prompted the present plans for completion.

Some form of removable block pavement in tunnels is considered necessary by the Port Authority because of the possibility of excess wear from close tracking of heavy traffic. Such removable blocks permit local repairs and replacements to be made quickly and easily with minimum interruption to traffic. The authority now has three different types of paving in three tunnels: granite block in the Holland; de-aired brick in the Lincoln; and the new type concrete block at George Washington Bridge.

### Easily installed

Installation of the concrete blocks is simple and fast. Preliminary to paving operations, a monolithic concrete base 4 in. thick was placed over the structural concrete floor of the tunnel, finished within a tolerance of ¼-in. deviation from a straight line in 10 ft. In the base are embedded 4-in. channels, covered with ½-in. copper-steel plates, to drain off excessive groundwater.

As the west portal is inaccessible because of other construction operations, all material must be delivered from the east end. The roadway, 22 ft. wide, is being paved half the width at a time, the first strip starting from the west end, the second from the east end.

After the base is thoroughly brushed and cleaned, it is given a sprayed prime coat of cutback asphalt. Then a mastic cushion of 93 to 96 per cent dry sand and 4 to 7 per cent cutback asphalt (by weight) is placed on the base. The mastic is hot mixed in the tunnel by a 7-S concrete mixer. Most of the time the sand comes sufficiently hot for mixing, being produced at a commercial asphalt plant, but a gasoline torch on the mixer provides additional heating of the mastic mix when necessary. Specifications require a minimum temperature of 60 deg. for the cushion mastic when placed.

From the mixer the mastic is hauled by wheelbarrow and dumped in front of a rolling wooden screed carrying a metal cutting edge. At first, attempts were made to roll the mastic to 1-in. uniform thickness, but the roller picked up so much material that a smooth surface was impossible to obtain. Consequently the screed was adjusted to spread the mastic 1¼-in. deep and the rolling was omitted. A light touch with a long-handled aluminum screed leaves the mastic surface in perfect condition.

Two men laying the blocks have developed a smooth technique in placing. They set the blocks on edge on the finished course, then tip them into place without disturbing the mastic. Blocks are laid in transverse courses with ⅛-in. to ¼-in. joints all around; each course is staggered half the block width, giving a checkered pattern of pleasing appearance.

Each course is started at the center of roadway, making the joint against the curb random width. In placing the first half of the roadway, half blocks are placed at the centerline in the alternate courses; when the second half is paved these are removed and replaced with full size blocks of white cement to serve as centerline markers. Special gore courses of tapered-width blocks are inserted at the curve within the tunnel.

When 50 ft. or so of pavement has been laid, 1-in. boards are placed longitudinally on the surface and the blocks are rolled with a 5-ton tandem roller. The surface is then checked with a 10-ft. straight edge, and any deviation of more than $\frac{3}{16}$ in. in this length is corrected. Removal of random blocks has shown that the settlement into the mastic cushion is never more than ⅛ in.

After rolling is completed, the boards are removed and the surface sprayed with a mixture of one part starch, twelve parts calcium chloride and 42 parts water to prevent the joint filler from adhering to the top surface of the blocks. The joints are filled with hot asphalt by hand, and excess bitumen on the top surface is removed by heated ice choppers.

On the first stretch the joints around the centerline half blocks are filled with sand for easy removal.

### Block making

Blocks are furnished by a commercial concrete products manufacturer. They are made of weight proportioned sand and trap rock aggregate of 1½-in. maximum size, roughly a 1:2:3 mix, and weigh 50 lb. each. Specifications require the blocks to show a modulus of rupture of at least 780 lb. per sq.in. at 28 days under simple beam third-point loading. The blocks, cast face down, are vibrated after pouring, and the top

# STEPS IN PLACING NEW TYPE TUNNEL PAVEMENT OF PRECAST CONCRETE BLOCKS

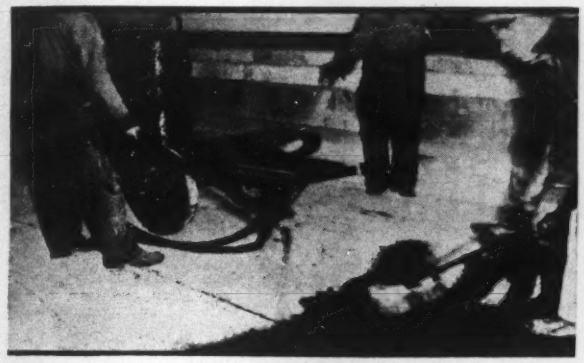


Fig. 1. Concrete base is sprayed with a prime coat of cut-back asphalt.

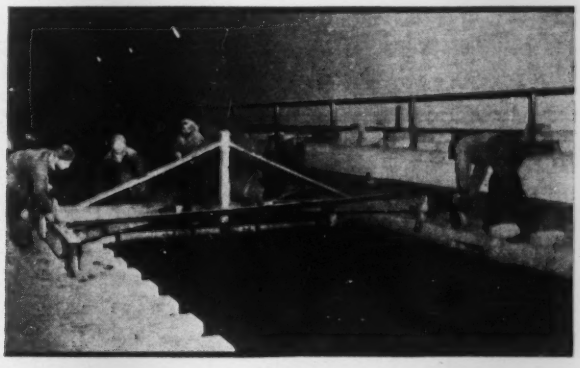


Fig. 2. Wooden screed on rollers spreads hot mastic of sand and asphalt as cushion for blocks.

Fig. 3. Blocks are dropped neatly into place by tipping off of last-placed course.

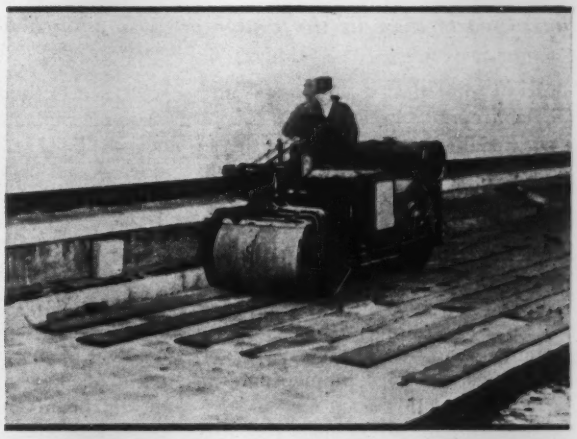


Fig. 4. Newly-laid pavement is rolled with small roller over a protection of 1-in. boards.

Fig. 5. Joints are hot-poured by hand, and excess filler is removed with heated scrapers.

Fig. 6. The completed pavement is smooth, clean and of pleasing appearance.

of the mold is struck off smooth under pressure to form the bottom of the block. After stripping, the surface is lightly brushed to expose the coarse aggregate as the wearing surface. All blocks are steam cured for 18 hr. and air-cured for 28 days. The finished block develops a compressive strength well in excess of 6,000 lb. per sq.in.

The paving crew consists of one foreman, a roller operator, two block layers and fifteen laborers, who work 7 hr. a day and finish 300 sq.yd. of paving. Exclusive of overhead, the paving is costing about $3.09 per sq.yd., divided as follows: blocks 27¢ each or $2.43 per sq.yd. at the plant; sand and asphalt, 16¢; labor, 50¢. Fred Hesse, veteran New York paving contractor, is supervising the pavement work for Frank Mascali & Son, general contractor on the tunnel floor finish.

For the Port of New York Authority, J. C. Evans is chief engineer, C. S. Gleim is engineer of construction and Royton F. Wheadon is resident engineer on the job, assisted by L. P. Tuttle and J. H. Shannon.

# Moment Coefficients for Haunched Beams

ODD ALBERT

Assistant Professor in Structural Engineering, Newark College of Engineering, Newark, N. J.

***Contents in Brief—For continuous beams with variable moment of inertia, a set of constants is developed which may be applied to the equations of the cantilever deflection method of design to give moment coefficient that correctly reflect the fact that more moment is taken at the supports than in the center of such haunched beams.***

TO AVOID the wastefulness and inaccuracy in designing beams with variable moment of inertia as though they had a constant section, the writer has calculated a table of constants, known as "beam integrals", which can be applied to the equations of the cantilever deflection method to determine the moment coefficients in continuous beams with variable moment of inertia. Such beams absorb more moment at the supports than in the center, and advantage should be taken of this useful condition.

The cantilever deflection method is based upon the various deflections of the free end of a member considered as a cantilever beam, fully restrained, with all the loads and influences of other members consider as loads. Each member is cut out of the system and treated separately as a cantilever beam, with first one end restrained and then the other, the degree of restraining being expressed by the deflection angle $r$ and the moment $M$ at the free end (Fig. 1a).

The deflections of the free end of a fully restrained beam with variable moment of inertia are based upon the discovery by Mohr that the total deflection of the free end of a cantilever beam equals the statistical moment of the $M/EI_x$ diagram with reference to the free end. In the case of a concentrated load $P$ at $B$ for beam $AB$ (Fig. 1b), which is considered as a cantilever fixed at $A$, the moment at a distance $x$ from $B$ will be $M_x = Px$ and, assuming a strip $dx$ wide, the statistical moment of this moment strip considered as a load with reference to $B$ will be $Px\ dx\ x$, and this value divided by the variable moment of inertia $I_x$ times the modulus of elasticity $E$, extended over all of the beam from $B$, with $x = 0$, to $A$, with $x = L$, will give the total deflection at the beam's free end $B$. Hence

$$d = \int_0^L \frac{Px^2dx}{EI_x} = \frac{PL^3}{3EI} x \frac{3I}{L^3} \int_0^L \frac{x^2dx}{I_x}$$

$$\text{or } d = \frac{PL^3}{3EI} i_1 \qquad (1)$$

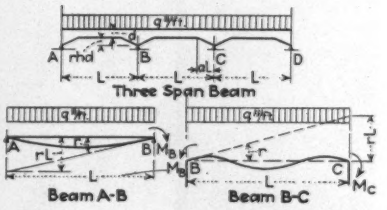



**Fig. 2.** Haunched beam in which moment at support $B$ is required for a uniform load. Beams $AB$ and $BC$ are isolated and considered as fixed cantilevers.

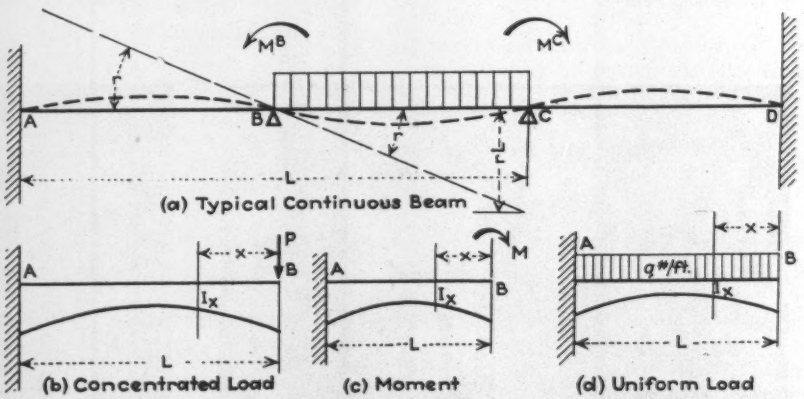
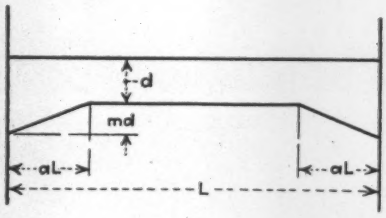



**Fig. 1.** Three-span beam with loading on middle span. In the cantilever design method each span is considered separately as a fully restrained horizontal cantilever with the deflections given from Eqs. (1), (2) and (3) for the loading conditions in (b), (c) and (d).

**BEAM INTEGRALS FOR A BEAM WITH SYMMETRICAL AND STRAIGHT HAUNCHES**




Values are given for various values of $m$ and $a$ in the diagram at the left. For such a symmetrical beam $i_3 = 2i_1 - i_2$

| | | Value of $m$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| $a = \frac{1}{6}$ | $i_1$ | 0.850 | 0.755 | 0.692 | 0.642 | 0.612 | 0.586 | 0.565 | 0.548 | 0.535 | 0.523 |
| | $i_2$ | 0.882 | 0.806 | 0.754 | 0.716 | 0.688 | 0.665 | 0.648 | 0.633 | 0.621 | 0.611 |
| | $i_3$ | 0.818 | 0.705 | 0.629 | 0.576 | 0.536 | 0.506 | 0.483 | 0.464 | 0.448 | 0.435 |
| $a = \frac{1}{4}$ | $i_1$ | 0.876 | 0.798 | 0.745 | 0.707 | 0.678 | 0.656 | 0.639 | 0.625 | 0.614 | 0.604 |
| | $i_2$ | 0.906 | 0.844 | 0.803 | 0.773 | 0.750 | 0.732 | 0.718 | 0.707 | 0.697 | 0.689 |
| | $i_3$ | 0.847 | 0.751 | 0.687 | 0.641 | 0.607 | 0.581 | 0.560 | 0.544 | 0.530 | 0.519 |
| $a = \frac{1}{3}$ | $i_1$ | 0.895 | 0.828 | 0.782 | 0.750 | 0.725 | 0.707 | 0.692 | 0.679 | 0.669 | 0.661 |
| | $i_2$ | 0.921 | 0.871 | 0.836 | 0.811 | 0.792 | 0.777 | 0.765 | 0.755 | 0.747 | 0.741 |
| | $i_3$ | 0.868 | 0.785 | 0.729 | 0.689 | 0.659 | 0.636 | 0.618 | 0.603 | 0.592 | 0.582 |
| $a = \frac{1}{2}$ | $i_1$ | 0.919 | 0.867 | 0.832 | 0.806 | 0.787 | 0.773 | 0.761 | 0.752 | 0.744 | 0.737 |
| | $i_2$ | 0.941 | 0.903 | 0.877 | 0.858 | 0.844 | 0.833 | 0.824 | 0.817 | 0.811 | 0.806 |
| | $i_3$ | 0.897 | 0.831 | 0.787 | 0.755 | 0.731 | 0.713 | 0.698 | 0.687 | 0.677 | 0.669 |

*References:* It will be noted that ($i_1$) corresponds to ($\phi\alpha$), and ($3i_2$–$2i_1$) to ($\phi\beta$) in Strassner's book *Neuere Methoded*, Vol. I, third edition, as given on page 85; that ($i_2$) corresponds to ($c_1$) and ($3i_2$–$2i_1$) to ($c_2$) in E. Suter's book *Die Methode der Festpnukte*, second edition, p. 727; the values ($i_1$) and ($3i_2$–$2i_1$) correspond also to ($\alpha$) and ($\beta$) in Taylor, Thompson & Smulski, Concrete, Vol. II, p. 138 (fourth edition).

where $i_1$ is used to represent the first beam integral.

Similar consideration for a moment $M$ applied at $B$ gives

$$d = \frac{ML^2}{2EI} i_{2\,a} \qquad (2)$$

where $i_2$ is used to represent the second beam integral.

Likewise, for a uniformly distributed load of $q$ lb. per ft.,

$$d = \frac{qL^4}{8EI} i_3 \qquad (3)$$

where the third beam integral is indicated as $i_3$.

It will be noted that the above derived formulas for the deflections are similar to formulas for the deflections of a beam with constant moment of inertia, and that they are identical with them in case the $i$-values equal unity, as they do when the beam has a constant moment of inertia. For beams with variable moment of inertia the $i$-values are always less than one and positive.

### Using beam integrals

In the continuous beam with equal spans on four haunched supports it is required to find the moment at support $B$ for a uniformly distributed load.

Each beam has the same shape (see Fig. 2) with $m = 1$ and $a = \frac{1}{4}$, so that, from the beam integral table

$i_1 = 0.612$, $i_2 = 0.688$, and $i_3 = 0.536$

Using the cantilever deflection theory, each individual beam is cut out and the deflections calculated from the above formulas. The total of these deflections must equal zero since the supports are assumed to be fixed.

For beam $AB$ (Fig. 2) consider end $B$ restrained and end $A$ free to move. The uniformly distributed load will tend to deflect this end while the reaction in $A$ will tend to push it up. Furthermore, the angle $r$ at support $B$ corresponds to a deflection of $rL$ at support $A$. The sum of these deflections must equal zero since the support is fixed. Therefore, if the formulas are used to indicate these deflections:

$$\frac{qL^4}{8EI} i_3 - \frac{AL^3}{3EI} i_1 + rl = 0 \qquad (4)$$

and, with a moment equation around $B$, we get

$$A = \frac{qL}{2} - \frac{M_B}{L}$$

so that the value of $r$ becomes

$$r = \frac{qL^3}{24EI} (4i_1 - 3i_3) - \frac{M_B L}{3EI} \qquad (5)$$

Next for beam $BC$ (Fig. 2) the deflection in support $C$ is figured. It will be noted that the moment acting in this support will tend to bend this end down. Thus the total effect of the deflections is

$$\frac{qL^4}{8EI} i_3 + \frac{M_C L^2}{2EI} i_2 - rL - \frac{CL^3}{3EI} i_1 = 0 \qquad (6)$$

As the beam is symmetrical, $M_C = M_B$, and

$$C = qL/2$$

These values substituted in Eq. (6) give

$$r = \frac{M_B L}{2EI} i_2 - \frac{qL^3}{24EI} (4i_1 - 3i_3) \qquad (7)$$

Combining Eq. (5) and (7) gives the moment at support $B$ to be

$$M_B = \frac{qL^2}{2} \frac{4i_1 - 3i_3}{3i_2 + 2i_1}$$

If the values of $i_1$, $i_2$, and $i_3$ are substituted, the actual moment is

$$M_B = \frac{qL^2}{7.8}$$

Should the beam be of constant moment of inertia, then all the beam integrals equal unity, and

$$M_B = \frac{qL^2}{10}$$

It will be noticed that the haunched beam will take more moment at the supports, thus relieving the middle part of the beam of positive moment.

• • •

## Night Accidents Decrease At Lighted Chicago Corners

Night accidents at three of Chicago's most hazardous street intersections have dropped 58 per cent since the installation of sodium safety lights, according to statistics compiled by Leslie J. Sorenson, city traffic engineer.

This reduction is shown by comparison of the number of night accidents at these intersections during the year previous to and the year following installation of the special luminaires. There were 95 accidents before and 40 after installation of the sodium units on Nov. 15, 1937, at Cicero and Diversey Aves., Chicago and Ashland Aves., and 79th St., Stony Island, and South Chicago Aves. Chicago's Utilities Research Commission paid for the sodium luminaires while the city furnished the labor for installation and has maintained the light during the test period. The commission has conducted the accident investigation with cooperation of Traffic Engineer Sorenson and the Chicago Police Department.

ENR Staff Photos

FIG. I. SEAWALL AND PROMENADE ON THE TAMPA WATERFRONT.

# Beauty and Utility In a Waterfront Improvement

***Contents in Brief**—Designed to dampen wave action and resist overturning, the new seawall at Tampa incorporates a number of interesting design features including a precast concrete railing. The waterfront improvement includes the construction of a six-lane divided highway paralleling the wall. All the work has been done by force account methods using WPA labor.*

A WATERFRONT IMPROVEMENT consisting of a seawall and a concrete highway, now being completed at Tampa, Fla., furnishes an example of a public works project of special utility and beauty. It also compels attention because of the engineering design of the wall which is built to break wave action and resist overturning. The highway design likewise includes several features representing good practice in facilitating traffic flow with safety.

Built along the shore of Hillsborough Bay, the 8,800-ft. wall protects valuable waterfront property, and replaces a structure erected in 1907 which had outlived its usefulness. Between the wall and the highway which parallels it, a 56-ft. strip of land has been set aside as a parkway. This is covered with grass and landscaped to provide a promenade of unusual charm. The layout and some of the detail features are shown on the opposite page.

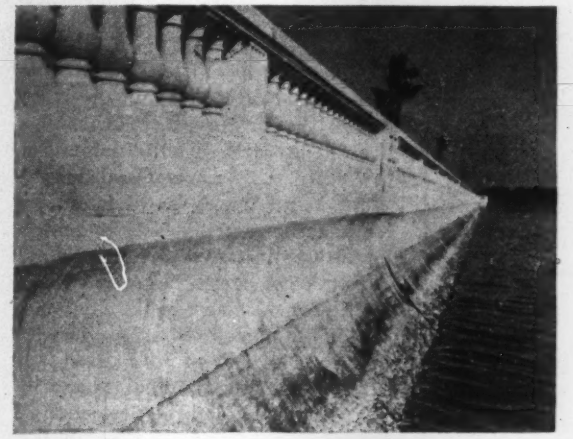
General design features of the concrete wall are shown in Fig. 3. The outside of the lower section is sloped at 45 deg. and the upper section is parabolic in shape. This has been done to direct wave action upward and outward; the net effect is to dampen the force of successive waves and thus prevent base scour, as well as to minimize the possibility of water overtopping the wall.

Fig. 2. R. H. Cason, city engineer of Tampa, and F. H. Horton, consulting engineer.

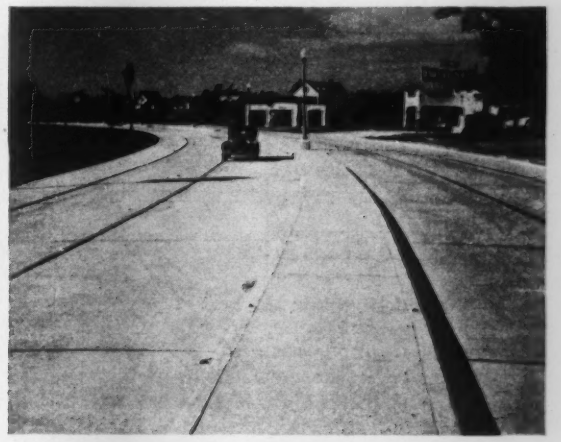
It will be noted that a vertical sheetpile wall is provided along the toe of the base. This cut-off wall extends about 6 ft. below the base to perform the dual function of retaining the backfill and checking teredo attacks on the bearing piles which are of southern yellow pine, untreated.

The baluster railing was installed following construction of the wall. The baluster spindles, 10,000 of which were needed, were pre-cast. Cast-iron vertical form split halves were employed for this purpose. A 1:1½:1 mix was used, the coarse aggregate of gravel having a maximum size of ¼ in. Twenty-one hours after a pour was made the forms were stripped from the spindles which were then rubbed with carborundum, finished in white rock dust (one part dust, one part cement) and buried in moist sand for curing.

## CAMERA GLIMPSES OF THE JOB

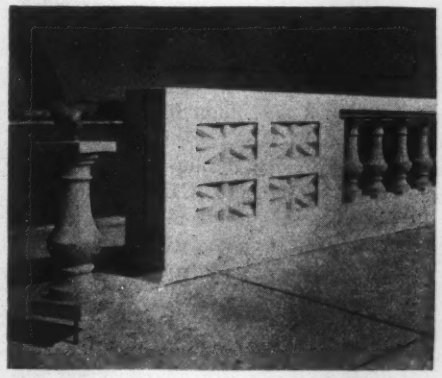


Parabolic wall face to dampen wave action.



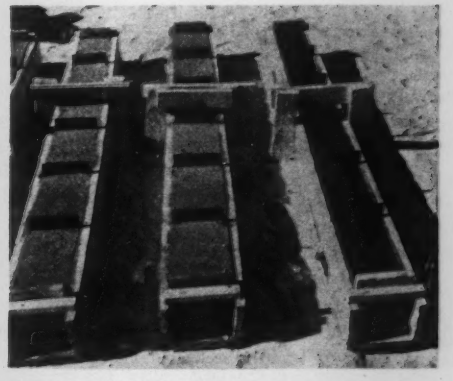
A six-lane divided highway for speed safety.

Generous proportions governed the layout of the highway and the promenade.



Precast spindle and the finished wall.

Curb reflector "eyes."



Precast blocks for bridge approach pavement.

When the balusters were mounted in the formwork along the wall, the plinth, cap and post to complete the railing were poured in place. The cost per foot of the wall averaged $69.

### Highway details

The highway which skirts the bay for three miles and gives an impressive entrance to the city, is a dual roadway on which opposing lines of traffic are separated by a raised center strip 6 ft. in width.

Three lanes which occupy a total width of 31½ ft. are provided in each roadway. The inside lane along the curb is reserved for parking purposes, the middle lane accommodates local and slow-moving vehicles, and the outer lane is for through traffic.

As a special safety precaution illuminating markers of the reflector type are installed on the curbs and on both sides of the roadway. These are spaced at 30-ft. intervals and consist of a small reflector element (about ⅜ in. in diameter) embedded in a metal holder. Catching the light from the headlights of moving cars they gleam like "eyes" in the darkness to outline

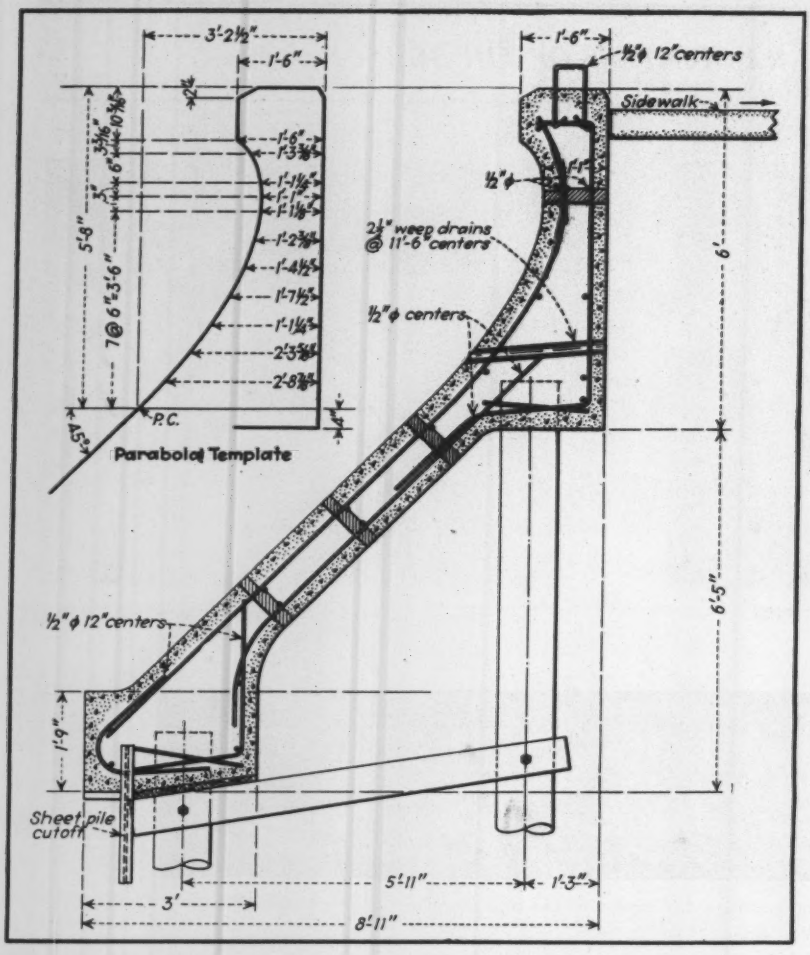



**Fig. 3.** Cross section of the seawall. The parabolic shape of the upper portion dampens wave action.

the edge of the curb. At intersections the markers are placed so as to reveal the outline of the raised center strip.

In addition to the curb markers, general illumination is provided from light standards located at 125 ft. intervals along the raised center strip.

The highway is of reinforced concrete construction 6 in. in thickness. The specifications follow those established by the Florida State Highway Department. In brief they call for 4,000-lb. concrete at 28 days, and reinforcement in the top only. The slab was poured in 10-ft. lanes with expansion joints every 100 ft., each such section being divided by dummy joints into units of 20 ft. each.

Where the highway connects with an existing bridge leading to the center of the city, a temporary concrete block pavement will be laid until full settlement of the fill has taken place. The blocks for this purpose are being made on the job, and some 20,000 will be precast. As shown in Fig. 3 simple wood forms accommodating six blocks are used. The blocks measure $4\frac{3}{8}$ x $4\frac{3}{4}$ in. They are made from a 1:2.3:3.2 mix, in which the coarse gravel aggregate does not exceed $\frac{1}{2}$ in. in size.

### Who's who on the job

The waterfront improvement was initiated and is being carried out under the direction of R. H. Cason, city engineer. Preparation of the design and supervision of the project was handled by Freeman H. Horton, consulting engineer for the city of Tampa. G. A. Youngberg, consulting engineer, reviewed the design and approved the construction methods.

The work is being done entirely with WPA labor, and W. E. Robinson, chief engineer of the Tampa District, Works Progress Administration, is in charge of this phase of the operation.

## Pollution Study Started on Red River

Announcement is made of the stream pollution survey now under way on the Red River. The survey is being conducted by the North Dakota State Department of Health with the cooperation of the Minnesota State Board of Health and the U. S. Public Health Service. Prime objective of the work, says the *Bulletin* of the North Dakota Water and Sewage Works Conference, is to obtain reliable data concerning the oxygen relationships in the stream before and during ice coverage, in order to make intelligent estimates of the minimum winter flows required in the interest of public water supplies, extent of dilution of treated municipal and industrial wastes, and the protection of the aquatic life which lives in this stream.

Samples are taken at least weekly from 15 stations on the river itself and at the mouths of all flowing tributaries, from Fargo to the International Border.

• • •

## Refuse Collection Service Charges

While most cities finance their refuse collection service in residential districts from general tax revenues, a few municipalities charge a fee. Collection charges are based for the most part upon frequency of collection in these cities. According to the American Public Works Association, Sacramento, Calif., is reported to collect refuse from the back door or basement once or twice a week and levy a charge of from 50c. to 75c. a month.

Oklahoma City, Oklahoma, collects garbage and combustible rubbish twice weekly from either the back door or the alley, and charges from $1.50 to $2 a month. Fresno, Calif. charges 45c. a month for one collection weekly of a 30-gal. can, and 80c. for two collections weekly of a 30-gal. can. Morgantown, W. Va., charges straight fees of $6 a year for collecting garbage and combustible rubbish, and $6 a year for ashes. The frequency of collection for the former is twice a week throughout the year, and for the latter twice a month.

# Relief Labor Builds A Sewage Treatment Plant

***Contents in Brief — Public sentiment for cleaning up the Des Moines River and necessity of finding large-scale work relief projects has produced a $1,500,000 sewage treatment plant for Des Moines in which the choice of type and design were governed largely to fit the labor available. The engineers made designs for simplified and repetitive construction. Sludge gas will be sold and electricity purchased.***

ABATEMENT of pollution in the Des Moines River by the Iowa capital city has been pressed for many years by the State Board of Health and local organizations. The advent of WPA and PWA brought the treatment program to a head in 1938, and a $1,500,000 20-m.g.d. plant involving sedimentation, trickling filters and separate sludge digestion is now well along toward completion. J. M. Tippee, city engineer, described the plant and the basis of design at a recent meeting of the Iowa Engineering Society and Paul Winfrey, resident engineer, showed pictures of the construction. From a recent visit to the plant and these talks the following notes are taken:

At first an activated sludge type of plant was favored since it was capable of producing a high degree of purification and was estimated to cost less than trickling filters. However, a large proportion of the original cost was represented by mechanical equipment whereas the trickling filter process was found to provide adequate treatment and would require the maximum amount of labor. And further, estimated operation costs favored the filter type.

Basic data for the design involve the following items: Population to be served is about 152,000; the industrial equivalent is 33,000. For 1956 the estimated population is 164,000 and the industrial equivalent 36,000. Present dry-weather flow is 16 m.g.d. and probable peak load to be taken by the plant is 30 m.g.d. The plant capacity is 20 m.g.d. The intercepter capacity is 66 m.g.d. Suspended solids in the sewage are 240 p.p.m. and the 5-day B.O.D. is 225 p.p.m.

### Method of operation

Entering the substructure of the pump and power house the sewage will pass through mechanically cleaned bar screens equipped with shredders, grit removal chambers, and then to a pump pit where it is to be lifted to a surge chamber. From this point gravity flow will carry it throughout the plant successively through the grease remover, flocculator, primary settling tanks, dosing tanks, trickling filters, secondary settling tanks and through the effluent channel over aeration cataracts to the river. Sludge from the primary tanks will be pumped to the digestion tanks. Sludge from secondary tanks goes to digesters, raw sewage pit or flocculators; digested sludge to sand beds.

As the flow may fluctuate from 10 m.g.d. to the 20 m.g.d. rate at which maximum operating efficiency is expected, provision is made to return the flow from the final settling tanks to the wet well. This can be done in any amount required to build up the rate of incoming sewage to the quantity which will insure the most desirable operation results. A

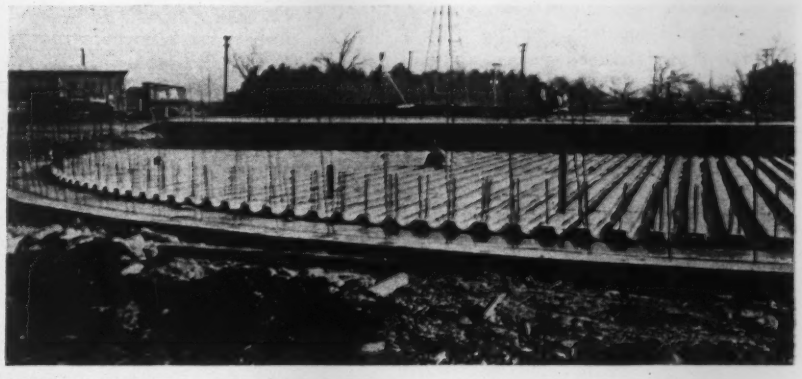


**Fig. 2.** Troughs in underdrain system of sprinkling filters were cast in place.

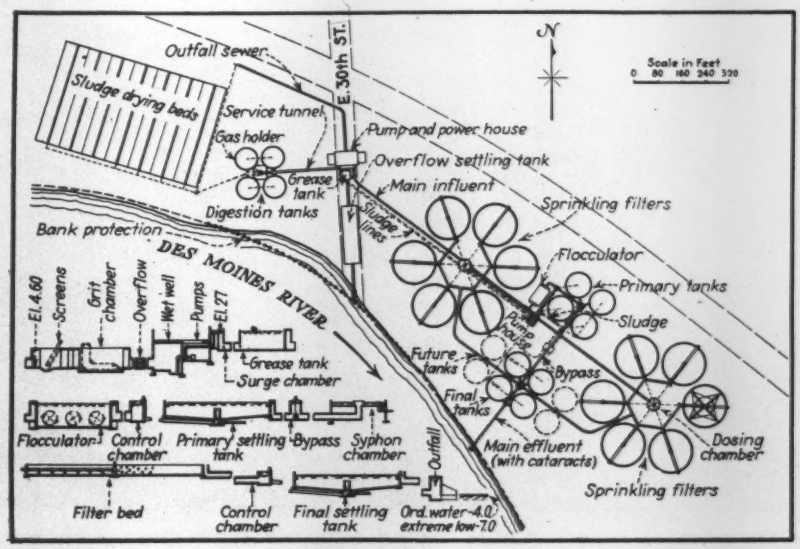



**Fig. 1.** Des Moines trickling filter sewage plant has two dozen round tanks.

final effluent averaging 30 p.p.m. B.O.D. and 45 p.p.m. suspended solids is anticipated.

Gas is to be used for heating the plant buildings and the sludge digestion tanks. The excess will be sold to the local gas company, which is a subsidiary of the local power and light company from which electrical power will be purchased. Should this arrangement prove unsatisfactory, gas engines may be installed. Gas production is expected to average 150,000 cu.ft. daily.

Units as follows make up the plant: two grit removal basins have flows of 1 ft. per sec.; two mechanical bar screens are followed by triturators to grind the screenings; four vertical centrifugal units of 7½, 10, 12½ and 15-m.g.d. capacity pump against a 31-ft. head; a grease removal tank with air diffusion has a detention period of 10 min.; a flocculator tank has three rows of paddles and retains the sewage 30 min.; four circular primary settling tanks, equipped with sludge removal mechanisms, will retain the sewage 2½ hr.; the 5 acres of trickling filters are in two batteries of six each, and each filter is 152 ft. in diameter; four final settling tanks have a detention period of 2 hr.; and the four digesters have a designed capacity of 2.56 cu.ft. per capita.

### Construction procedure

Due to the use of unskilled labor and intricate nature of the work the engineering department made upward of 1,000 drawings, a model of the whole plant and detailed models of other structures. Formwork was entirely of wood and of as much simplicity and duplication as possible. For instance the walls of the many round tanks were not battered but brought up with constant thicknesses changed at three points. The half-round underdrain gutter forms were made of 8-ft. lengths of sheet steel and were held to grade and secured against upward pressure of concrete during pouring by ingenious ties. Good workmanship was obtained throughout.

The entire construction, excavating, grading and concrete work up to February was carried out by WPA. Recently PWA contracts have been let for the brick superstructure of the pump and powerhouse and electrical installations. Much winter work was done as the WPA load is heaviest at that season, some 2,100 men being employed at the peak. Other equipment contracts with PWA aid will follow. The plant is scheduled to be put into operation some time during this summer.

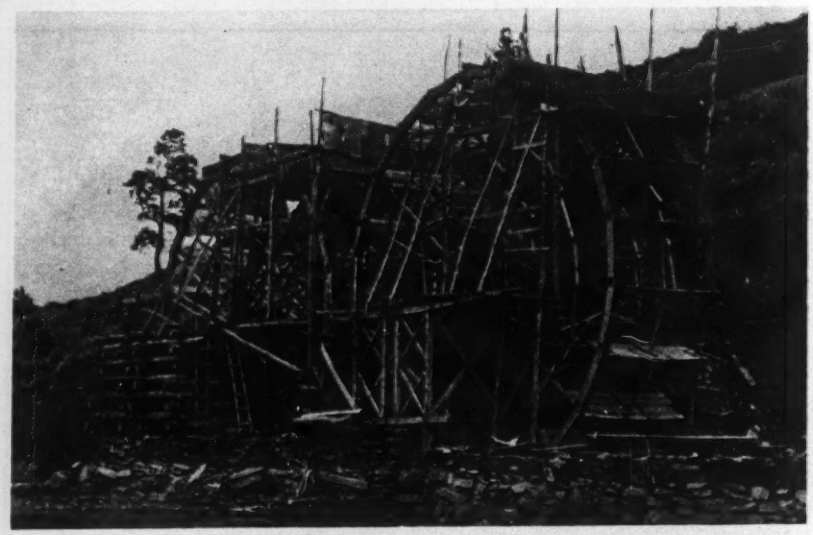
Designs and construction have been carried out by the engineering department under the direction of J. M. Tippee, city engineer, and Paul Winfrey, resident engineer.

# Large Home-Made Water Wheels Lift Water for Irrigation

TWO LARGE WOODEN WHEELS of the "undershot" type for lifting water are operating on the Yellowstone River about 10 mi. from Columbus, Mont., where Harlan Milligan has devised and built his own irrigation system. The wheels are 42 ft. in diameter and lift water almost this height to a wooden flume leading to main flumes in fields on the adjoining bench.

The timber used in constructing the wheels was all rough-sawn nearby excepting the spokes which were purchased from a mill because they had to be planed. Unlike water buckets commonly used on under-shot wheels of the early days, these wheels pick water up in long narrow boxes, built into the rims on both sides of the wheel, one box between each pair of spokes. On one wheel the boxes are 5 ft. long by 6x9 in. in section. The other wheel has boxes 6 ft. long with 6x8-in. sections. The opening is at the box end; as the wheel rotates the boxes fill with water at the bottom and at the top empty into troughs. The paddles on which the current acts are 11 ft. 8 in. long (the width of the wheel) and 4 ft. deep. The distance between paddles equals the water box length.

A wing dam extending upstream into the channel for about ¼ mi. deflects river flow toward the weels in low water periods. Nearer the wheels the channel is established by a stone wall 11 ft. high. With this arrangement a fall of about 8 ft. occurs in the ¼-mi. channel and in seasons of ordinary flow there is sufficient water to operate the wheels throughout the summer. Water depth at the wheels has to be about 4 ft. to run them at full capacity. The entire installation is estimated to have cost $4,000 to $5,000, of which not more than $1,400 or $1,500 is in the wheels.



**Undershot water wheels 42 ft. in diameter on the Yellowstone River. Water boxes on wheel peripheries discharge into flumes parallel to the wheel near the top, which connect with cross flumes leading to the main flumes on the high bench.**

# FROM FIELD AND OFFICE

*Working problems and time-saving methods . . . Edited by Charles S. Hill*

## Simple Curve Solution

A. L. EATON
Roanoke, Virginia

In mountainous and rough country where the *P.I.*'s of curves are often inaccessible the following solution will be found convenient. The solution allows the use of a simple curve and gives the locator a method for the control of the line of curvature by locating the line *ab* in the sketch. Then

$\text{Tan } \frac{1}{2}A : \text{Tan } \frac{1}{2}A + \text{Tan } \frac{1}{2}B :: x : 250$

$.28675 : .28675 + .50953 :: x : 250$

$.79628\ x = 71.6875$

$x = 90$

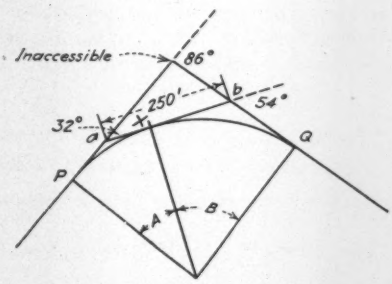



**Diagram for locating a curve**

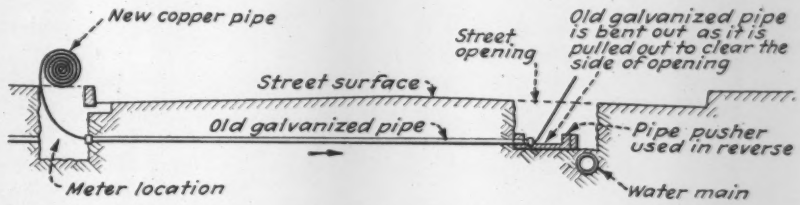
From the field tables it will be found that a curve with an angle of intersection of 32 deg. and a tangent distance of 90 ft. will be an 18 deg. and 30 min. curve. It remains then to lay off the tangent distance of $aP = 90$ ft. and $bQ = 160$ ft. and run in a curve of 18 deg. and 30 min.

• • •

## Replacing Service Pipes

ARTHUR M. FIELD
City Manager, Winchester, Va.

One of the principal causes of leakage from water distribution systems is the rusting through of galvanized water-service pipes. Generally, when one service in a block of houses erected at about the same time goes, the others in that block will soon follow and should be carefully watched. The cost of replacing these services is considerable and it can be materially reduced when copper pipe is used as illustrated.

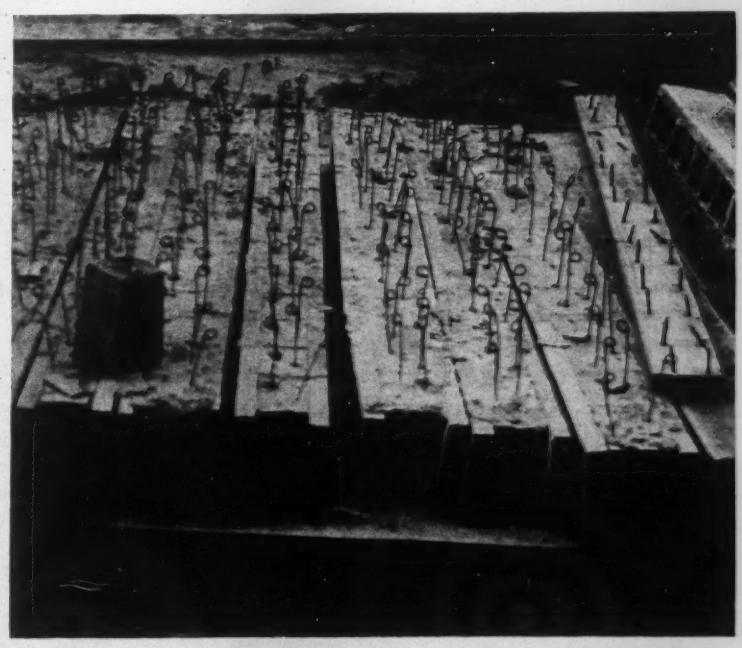

New copper pipe
Street opening
Old galvanized pipe is bent out as it is pulled out to clear the side of opening
Street surface
Old galvanized pipe
Pipe pusher used in reverse
Meter location
Water main

**Method of replacing iron service pipe with copper pipe.**

An opening is made in the street at the main about 4 ft. along the line of the service and about 2½ ft. wide. A second opening is made at the meter back of the curb, just large enough to enable the old pipe to be disconnected. When the old pipe is disconnected from the meter, a coil of new copper service pipe is attached to it with a nipple.

At the main the old pipe is disconnected from the main after the water is shut off and a pipe pusher is put into the hole in reversed position. The old galvanized pipe is pulled out and as it comes out it pulls the new copper service after it. When the pipe pusher-puller has pulled out a section the length of the opening, the pipe is cut off or very often it can simply be bent up so that the end will clear the hole as the pipe comes out.

Over 200 of these reinstallations have been made and only once has the galvanized pipe broken during the pulling; even a ¾-in. copper pipe can be pulled in after a ½-in. galvanized pipe successfully.



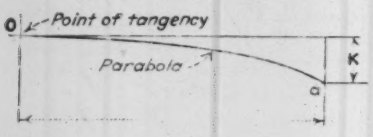
**PRECASTING CONCRETE CHAIRS**

Concrete blocks or chairs to support reinforcing bars for use in the recently completed Galveston Causeway (*ENR* Sept. 15, 1938) were made in quantity in the wood form shown at the extreme right. Wires to secure the bars to the chairs were imbedded in the wedge-shaped blocks.

## Length of Parabolic Arc

E. I. FIESENHEISER and F. J. SAUER
U. S. Bureau of Public Roads,
St. Paul, Minn.

Next to the circle the parabola is probably the most used curve. While the length of the parabolic arc is not often required yet in certain cases it may be desirable. The problem is not




difficult for the mathematician but for those who prefer a formula the following will give the desired result where $S$ = length of arc $oa$ in the diagram:

$$S = \tfrac{1}{2}\sqrt{L^2 + 4k^2} + \frac{L^2}{4k}\,\mathrm{Log}\left[\frac{2k + \sqrt{L^2 + 4k^2}}{L}\right]$$

The above formula is for use with natural logarithms. When ordinary common logarithms are used the second term must be multiplied by the log of 10 to the base $e$ which is equal to 2.30258510 . . . Ordinarily five significant figures will be sufficient and the formula becomes:

$$S = \tfrac{1}{2}\sqrt{L^2 + 4k^2} + (.57565)\frac{L^2}{k}\,\mathrm{Log}\left[\frac{2k + \sqrt{L^2 + 4k^2}}{L}\right]$$

The formula is derived from the expression for the length of an arc

$$S = \int_0^L \left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{1}{2}} dx$$

For this case

$$y = \frac{x^2}{L^2}k;\ \frac{dy}{dx} = \frac{2kx}{L^2}\ \text{and}$$

$$S = \frac{2k}{L^2}\int_0^L \left[\left(\frac{L^2}{2k}\right)^2 + x^2\right]^{\frac{1}{2}} dx$$

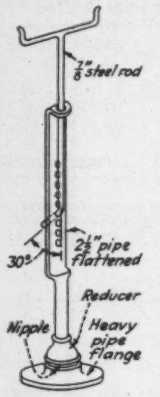
The formula is a solution of the above integral.

• • •

## Stand for Machine Shop

An adjustable stand convenient for supporting one end of a steel beam while the opposite end is in the drill press, or for the many other machine-shop operations where support is required temporarily for some projecting part, can be made from materials at hand as shown in the accompanying sketch.

The hole in the head for allowing the main shaft to slide up and down should be large enough for free movement and to permit of tilting when inserting the lower end into a hole at the desired height. To make sure of safely locking the shaft at any height, the lower part of the rod should make an angle of not more than 30 deg. with the vertical. The holes can be bored about 2 in. apart for the range of extension desired.

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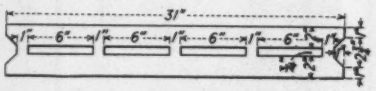
## Marking Gutter Grades

F. D. EASON
Division Engineer, Oregon Highway Commission, Salem, Ore.

The retention of gutter grades on curbs during paving has always been a problem, due to the impossibility of keeping a mark made by the ordinary chalk-line method from being obliterated between grade points by the paving materials as they are placed. The difficulty was recently successfully overcome, on Court St., in front of the new capitol building in Salem, Ore., by the use of a stencil shown by the accompanying sketch, a stencil brush and quick-drying yellow lacquer paint.




**Stencil for painting gutter grades on curbs.**

The method was first to snap a chalk line between grade points to serve as a temporary guide line. Then by placing the lower line of the opening in the stencil on the guide line and painting over the stencil, a permanent gutter grade line was established, ¾ in. wide. The reason for the ¾-in. width of line was to assist the finishers, as the ordinary wood hand float used in finishing concrete is ¾ in. thick. This simplified the control of the gutter line as all the float operator had to do was to watch the top of the painted line and the top of his float to see that he was on the proper grade.

It was found that in snapping chalk lines around curbs having a batter, it was necessary to use a small carpenter's level and snap at short intervals to secure a uniform guide line between grade points. Grade points were set at 5-ft. intervals on curved curbs and at 25-ft. intervals on tangents.

The method also served as a very good check on grade points due to the visibility of the painted line, which would show up any irregularities. The method was devised by Hedda Swart, resident engineer, Oregon state highway department.

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*FIELD & OFFICE COMMENT*

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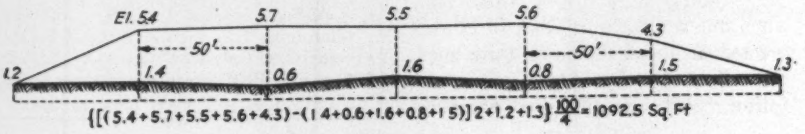
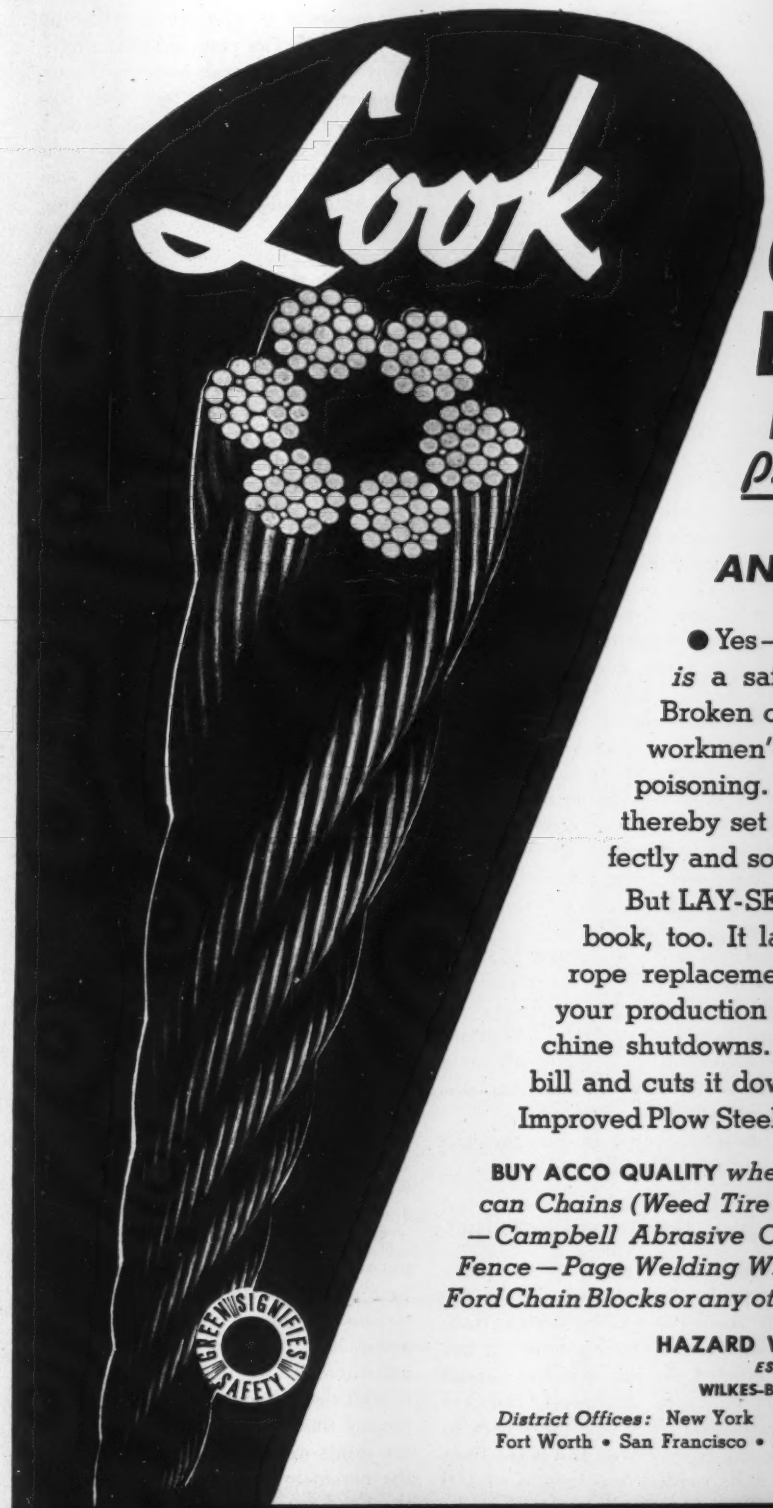
## Area Of Wide Fill Sections

Sir: In the *ENR* Field and Office Section, Aug. 25, 1938, p. 245, a method was given for calculating cross-sections with the Monroe calculating machine. A somewhat similar but simpler method can be applied to the more extensive cross-sections of dredge fills, borrowpits, etc., where the readings are taken at regular intervals. Multiply the difference between the sums of the top and bottom elevations by two, add the difference of the ends and multiply by 100/4 for 50-ft. stations or 100/8 for 25-ft. stations. A computed example is given by the accompanying illustration.

C. F. YOUNG
*Civil and Landscape Engineer, St. Petersburg, Fla.*



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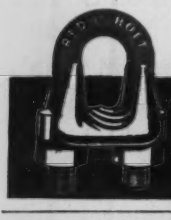
The Genuine CROSBY WIRE ROPE CLIP is designed to grip wire rope securely without injuring it; Drop Forged from finest steel and Hot Galvanized.

IT IS THE CHEAPEST CLIP, BECAUSE IT IS THE SAFEST CLIP.



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Low In Operating And Maintenance Costs
High In Capacity And Durability

LOCK JOINT
*Reinforced Concrete*
PRESSURE PIPE

LOCK JOINT PIPE COMPANY
AMPERE, N. J.

## *ABSTRACTS AND NOTES*

### Research Opportunities

Needs and advantages of technical research, and the difficulties of obtaining funds for many desirable lines of study, were stressed in the 1938 annual report of Karl T. Compton, president of the Massachusetts Institute of Technology. In substance, he considered that the greatest opportunity for benefitting the human race is through research, and states that for lack of funds the work now being done is only scratching the surface of what might be done. As an example, he said it had been found that organic materials such as decayed vegetation may bring certain soils into a colloidal condition in which they are almost impervious, so that rain water will run off rapidly, in a manner tending to cause floods. But it has been suggested that by the application of chemicals in small amounts the soils may be made permeable. This he considered a field for useful study. Preliminary experiments have given promising results, but efforts to secure funds for necessary further tests have not been successful. The difficulty lies in the fact that this is but one of a hundred similar opportunities. As a result, much effort is expended in trying to find ways and means for prosecuting proposed investigations, but, said Dr. Compton, "we succeed in a minority of cases and the rest drag on to haunt us with an ever-increasing memory of lost and vanished opportunities through enforced negligence."

### Welding Rails in Australia

A rail-welding plant of the flash-butt type has been purchased by the South Australian Government Railways and a rail-welding building has been erected. As stated in the annual report of C. S. Anderson, railways commissioner, it is now the policy to carry out renewals on the main lines with rails welded into lengths of 160 ft. or 200 ft.

### Water Supply for Fires

Extensive increase in water supply available for fire emergencies is planned in London, England, and a general project for such increase on a large scale is to be submitted to the city council. The plan includes alterations to the several municipal outdoor swimming pools to enable fire department equipment to obtain direct access to them or to obtain water by means of permanent suction pipes laid from the pools to convenient points for fire connections. Surveys have been made of lakes and ponds in the public parks and of rivers and canals within the city in order to locate points of ready access for the fire engines. Barges fitted with pumps may be installed on the waterways. Methods have been developed also for relaying water for distances up to four miles by means of pumps and hose. Other tentative plans include the use of canvas tanks holding 1,400 to 12,000 gal., and the construction of underground tanks of 200,000-gal. capacity.

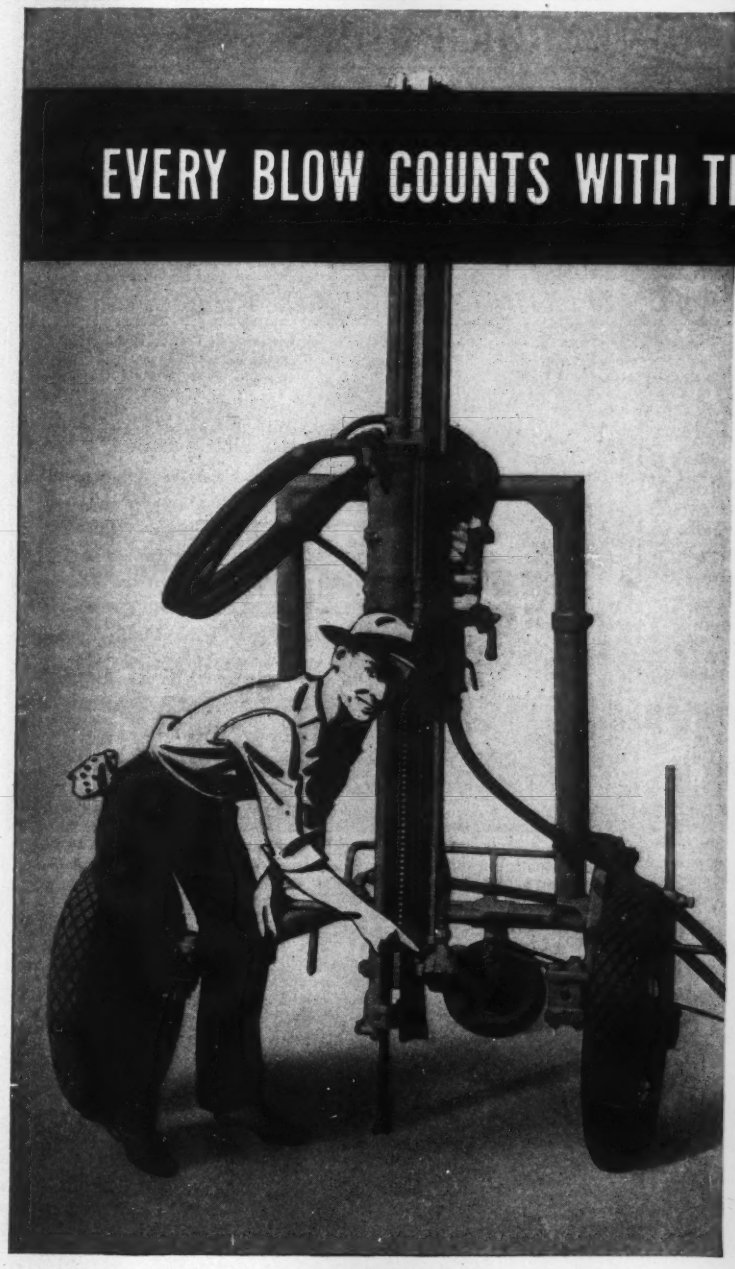
### Brick-Concrete Streets

Broken brick as coarse aggregate for concrete paving has been used in resurfacing streets at Louisville, Ky., thereby utilizing the old brick paving of the same streets. As described in the January-February issue of "Concrete Highways" (publication of the Portland Cement Association, Chicago), the bricks were loosened from their concrete base by means of pneumatic drills and were thrown into a small portable crusher, the output of which was turned over with forks for removal of the fines and dirt. Of the cleaned broken brick, the percentages passing the several screens were as follows: 2-in. screen, 90 per cent; 1½-in., 85; 1-in., 67; ½-in., 25; and ¼-in., 2 per cent. Fine clean gravel was added to fill the voids and make a workable mix of 1:2:4 by volume.

The work was done in three parallel strips, the side or curb strips first and then the middle strip. Expansion joints were spaced 40 ft. apart, the old concrete base being cut through so that the joints extended the full depth of the new 6-in. paving slab and its base course. Dummy joints were made midway between the expansion joints. Cores cut from the brick-concrete showed a compressive strength of 3,500 to 4,200 lb. at 28 days. Cylinders broken at 28 days ranged from 3,200 to 4,900 lb., with an average of 3,875 for 13 specimens.

A crew of 15 to 20 men averaged 175 sq.yd. of finished paving per day.

# EVERY BLOW COUNTS WITH THE CLEVELAND DR8



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## LEADERS IN DRILLING EQUIPMENT

# MATERIALS AND LABOR PRICES

*Market quotations on construction materials and wage rates reported monthly by ENR correspondents*

APRIL construction material prices as a whole show only minor changes from last month. Short Leaf Yellow Pine is $1.00 higher in Atlanta, and up 25c. on 2x6-in. and 2x8-in. sizes in Cincinnati. Spruce is off $2.00 on the same sizes in Boston. Douglas Fir is $2.00 lower on the smaller sizes in Boston; $1.00 lower on most 2-in. sizes in Chicago; but up 50c. on 1x8-in. in Philadelphia.

Cement is up 34c. per bbl. in Cleveland, and 5c. higher in New York. Sand is 5c. per ton lower in Detroit. Paving brick is up $1.50 per M in Boston, while granite blocks are off $5.00 per M. Paving asphalt is $1.00 per ton higher in Cincinnati.

Common brick prices increase $1.00 per M in Atlanta, and 50c. in New York. Structural clay tile is up on all sizes in Cincinnati.

In Cincinnati, carpenters' rate which formerly ranged from 70c. to $1.45 per hour are now $1.45; hoisting engineers' rate, formerly ranging from $1.00 to $1.525, and plasterers' rate which was $1.00 to $1.625, have closed the gap and the higher rates now prevail. The structural iron workers' new rate in Boston is $1.50 per hour, compared with $1.80 reported previously.

Common labor rates in Baltimore are up 6¼c. from the 50c. per hour rate a month ago.

## CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

| | PORTLAND CEMENT | | | SAND AND GRAVEL | | | CRUSHED STONE | | CRUSHED SLAG | | CONCRETE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included | | | Per ton, carload lots | | | Per ton, carload lots | | Per ton, carload lots, f.o.b. plant | | Ready Mixed 1:2:4, 50 c.y. or more, delivered |
| | Cloth Bags[a] | Paper Bags | Bulk | Gravel, 1½ in. | Gravel, ¾ in. | Sand | 1½ in. | ¾ in. | 1½ in. | ¾ in. | |
| Atlanta | $2.90 | $2.65 | $2.60 | $1.75 | $1.85 | $1.95 | $1.65 | $1.75 | $1.55 | $1.65 | $7.75 |
| Baltimore | 2.31 | 2.06 | 1.91 | 1.75‡ | 1.75‡ | 1.25‡ | 1.75‡ | 1.75‡ | 1.75‡ | 1.75‡ | 6.75 |
| Birmingham | 2.55 | 2.30 | 1.99 | 1.80 | 1.80 | 1.45 | 1.00 | 1.00 | .90 | 1.15 | 5.45 |
| Boston | 2.75[b] | 2.50[b] | 2.30 | 1.10 | 1.10 | .80 | 1.10 | 1.10 | .... | .... | 6.75[m] |
| Chicago | 2.60 | 2.35 | 2.20 | 2.00‡[d] | 2.00‡[d] | 2.00‡[d] | 2.00‡[d] | 2.00‡[d] | 1.25‡ | 1.25‡ | .... |
| Cincinnati | 2.47 | 2.22 | 2.07 | 1.20 | 1.20 | 1.30 | 1.80 | 1.80 | .... | .... | 6.60 |
| Cleveland | 2.29 | 2.04 | ...[i] | 1.45[i] | 1.45[i] | 1.45[i] | 1.70[i] | 1.70[i] | 1.70[i] | 1.70[i] | 6.65[i] |
| Dallas | 2.30 | 2.05 | 1.85 | 2.00[p] | 2.00[p] | 1.50[p] | 1.69[p] | 1.84[p] | .... | .... | 6.40 |
| Denver | 3.02 | 2.77 | .... | 1.20 | 1.40 | .90 | .... | .... | .... | .... | 7.25 |
| Detroit | 2.15 | 1.90 | 1.70 | 1.05 | 1.15 | .80 | 1.45 | 1.45 | 1.50‡ | 1.50‡ | 6.50 |
| Kansas City | 2.56 | 2.31 | 2.16 | 1.85 | 2.30 | 1.00 | 1.91 | 1.91 | .... | .... | 7.90[n] |
| Los Angeles | 2.82[b] | 2.62[b] | .... | 1.10 | 1.10 | 1.10 | 1.10[f] | 1.10[f] | .... | .... | 6.35 |
| Minneapolis | 3.00 | 2.75 | .... | 1.00[h] | 1.00[h] | .25[h] | 1.00[h] | 1.00[h] | .... | .... | 7.85[j] |
| Montreal | .... | .... | 1.58 | .... | .... | 1.25‡ | .90‡[c] | 1.00‡[c] | .... | .... | 7.60[l] |
| New Orleans | 2.41 | 2.16 | .... | 1.50 | 1.50 | 1.25 | .... | .... | .... | .... | 7.25 |
| New York | 2.60‡ | 2.35‡ | .... | 1.40[de] | 1.40[de] | .90[de] | 1.65[de] | 1.75[de] | .... | .... | 7.25 |
| Philadelphia | 2.32 | 2.07 | 1.87 | 1.55‡ | 1.65‡ | 1.25‡ | .... | .... | 1.00 | 1.00 | 7.95[k] |
| Pittsburgh | 2.44 | 2.19 | 1.99 | 1.80‡ | 1.80‡ | 2.10‡ | 2.25‡ | 2.25‡ | 1.50 | 1.50 | 8.75 |
| St. Louis | 2.55 | 2.30 | .... | 1.50‡ | 1.50‡ | 1.25/1.50‡ | .85[h] | .85[h] | .75[g] | .75[g] | 7.50 |
| San Francisco | 2.72 | 2.52 | 2.20 | 1.35 | 1.35 | 1.35 | 1.50 | 1.50 | .... | .... | 7.50 |
| Seattle | 3.10[o] | 2.85[o] | .... | 1.17[o] | 1.17[o] | 1.17[o] | 1.33[o] | 1.33[o] | .... | .... | 7.30[o] |

‡ Delivered. [a] 10c. allowed for each returnable bag. [b] 10c. per bbl. off for cash. [c] Plus municipal tax. [d] Per cu. yd. [e] Barge lots alongside docks [f] Crushed granite. [g] F.o.b. Granite City, Ill. [h] F.o.b. plant. [i] Within three miles of Public Square. [j] 5% discount for cash. [k] Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. [l] Up to 200 cu. yd. [m] 50c. off for cash. [n] 25 c.y. or more. [o] 2% off for cash. [p] 10c. per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

**CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL**

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

| | Bagged | Bulk | | Bagged | Bulk | | Bagged | Bulk |
|---|---|---|---|---|---|---|---|---|
| Buffington, Ind | $1.70 | $1.65 | Ironton, Ohio | $1.60 | $1.55 | Richard City, Tenn | $1.80 | $1.75 |
| Dallas, Tex. (Inc. 5c. tax) | 1.80 | 1.75 | Limedale, Ind | 1.70 | 1.65 | Steelton, Minn | 1.80 | 1.75 |
| Hannibal, Mo | 1.70 | 1.65 | Norfolk, Va | 1.65 | 1.60 | Universal, Pa | 1.65 | 1.60 |
| Hudson, N. Y | 1.75 | 1.70 | Northampton, Pa | 1.55 | 1.50 | Waco, Tex. (Plus 5c. Tax in Texas) | 1.75 | 1.70 |
| Independence, Kans | 1.70 | 1.65 | North Birmangham, Ala | 1.70 | 1.65 | | | |

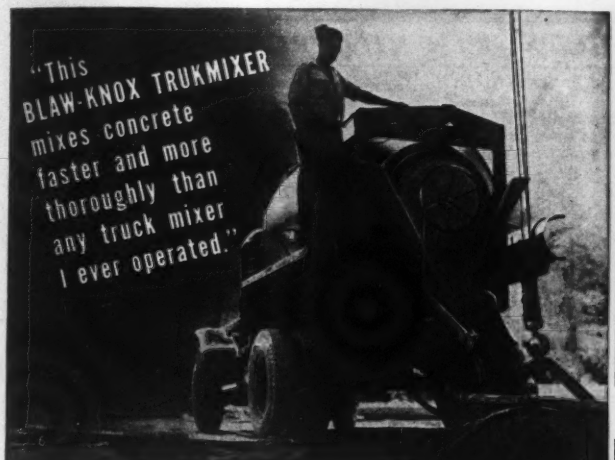
LOWER PENINSULA MICHIGAN. Uniform carload lot cement price established March 1937.

## PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

| | PAVING BRICKS AND BLOCKS | | | PAVING ASPHALT | | ASPHALT BINDERS — FLUXES | | CUTBACK ASPHALT | | ROAD OILS | ASPHALT EMULSION (Quick-breaking) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Granite per M. lots of 50,000 4x4x8 in. | Brick per M. 3x4x8½ in. carload lots | Wood per sq. yd. 3½ in. 16-lb. treat | Per ton, less than 80 penetration | | Per gal. 80–300 penetration | | Per ton | | Per gal. | Per gal. |
| | | | | Tank car | Drums | Tank car | Drums | Tank car | Drums | Tank car | Tank car | Drums |
| Atlanta | $75.00 | $39.35 | $2.25 | $16.60[e] | $21.80[e] | $0.0675[e] | $0.0968[e] | $0.0734[he] | $0.1053[he] | $0.0584[e] | $0.0834 | $0.0834 |
| Baltimore | 140.00 | 44.00‡ | 2.50 | 13.00 | 18.00 | .05 | .08 | .06[h] | .09 | ..... | ..... | ..... |
| Birmingham | ..... | 25.00 | ..... | 18.20 | 23.40 | .0747 | .1047 | .0834[h] | .1134[h] | ..... | ..... | ..... |
| Boston | 80.00 | 46.50 | 3.00 | 13.00 | 19.00 | .05 | .08 | .06[h] | .09[h] | ..... | .09‡ | .12‡ |
| Chicago | 140.00 | 52.00 | 2.60 | 14.00 | 18.00 | 13.00[g] | 17.00[g] | .06[h] | .11[h] | .03 | .08 | .12 |
| Cincinnati | 112.00 | 37.50 | ..... | 14.31 | 18.31 | .10 | ..... | 18.00 | ..... | .0525 | .08 | ..... |
| Cleveland | 110.00 | 37.25 | 2.80 | 15.25 | 20.50 | .07 | .08 | .07[h] | .085[h] | .05 | .08 | .09 |
| Dallas | ..... | 30.50 | ..... | 12.00 | 17.00 | .04 | .07 | 13.00 | 18.00 | .035 | .05/.07 | .07/.09 |
| Denver | ..... | 27.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Detroit | ..... | 35.00 | ..... | 14.10[f] | 20.00[f] | 14.00[g] | 18.40[g] | 14.00 | 19.70 | .0535 | .066 | .0995 |
| Kansas City | ..... | 44.00 | ..... | 18.50 | 23.50 | .077 | .1075 | .077[h] | .107[h] | .057 | .11 | .15 |
| Los Angeles | ..... | 50.00 | ..... | 6.50[b] | 15.00 | 6.50[b] | 15.00[g] | 5.50[b] | ..... | .0192 | .0525 | .1125 |
| Minneapolis | ..... | ..... | 1.90[d] | 19.20 | 24.20 | .10 | .12 | 19.30 | 28.30 | .056 | ..... | ..... |
| Montreal | 82.50 | ..... | 3.62 | 14.60 | 21.25 | .105 | .1375 | .101[h] | .121[h] | .0935 | .13 | .16 |
| New Orleans | ..... | ..... | ..... | 14.00[a] | 19.00[a] | .055 | .085 | .06[h] | .09[h] | ..... | .078 | ..... |
| New York | ..... | 68.00 | 2.80 | 13.50 | 18.50 | .055 | .08 | .06[h] | .09[h] | ..... | .0725 | .1035 |
| Philadelphia | 120.00 | 42.50 | 2.84 | 14.00 | 19.00 | .055 | .08 | .06[h] | .09[h] | .05 | .06 | .09 |
| Pittsburgh | 115.00 | 40.00 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| St. Louis | 110.00/121.00 | 37.00 | ..... | 12.00 | 16.00 | .055 | .085 | .06[h] | .09[h] | .035 | .08 | .11 |
| San Francisco | ..... | 70.00 | ..... | 6.50 | 15.00 | 6.50[g] | 15.00[g] | 7.00 | 17.50 | .025 | .0475 | .117 |
| Seattle | ..... | 60.00[c] | ..... | 13.90 | 22.90 | ..... | 24.50[g] | 9.50/10.50 | 23.00/24.00 | 7.75 | .0575 | .1308 |

‡ Delivered. [a] F.o.b. Baton Rouge. [b] Delivered to purchaser's warehouse. [c] 3½x4x8½ in. [d] 2½ in. 6 to 8-lb. treatment. [e] Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. [f] Mexican. [g] Per ton. [h] Per gallon.

(Continued on page 78)

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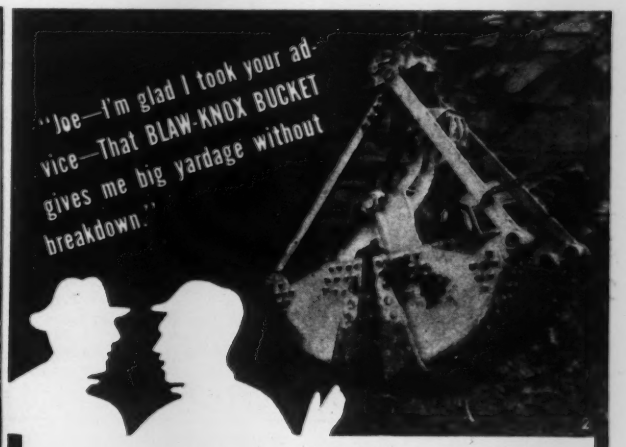


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**BLAW-KNOX**
*Portable* **BATCHERPLANTS**

(Continued from page 76)

## IRON AND STEEL PRODUCTS—BASE MILL PRICES

| | STRUCT. SHAPES-PLATE | REINF. BARS ¼-in. billet *b* | RIVETS ½-in. structural | WIRE NAILS Base *d* | SHEET PILING Base | STEEL RAILS Per Gross Ton Standard | Light | Re-rolled | TRACK SUPPLIES Angle Bars | Std. Spikes *c* | Tie Plates *c* | Track Bolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birmingham | $2.10 | $2.05 | $3.40 | $2.45 | .... | $40.00 | $40.00 | $39.00 | $2.70 | $3.00 | $2.15 | $4.15 |
| Chicago | 2.10 | 2.05 | 3.40 | 2.45 | $2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Pittsburgh | 2.10 | 2.05 | 3.40 | 2.45 | 2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Buffalo | 2.10 | 2.05 | .... | .... | 2.40 | .... | .... | .... | .... | .... | 2.15 | .... |
| Cleveland | 2.10 | 2.05 | 3.40 | 2.45 | .... | .... | .... | .... | .... | .... | .... | .... |
| Youngstown | .... | 2.05 | .... | .... | .... | .... | .... | .... | .... | 3.00 | .... | .... |
| Detroit | .... | 2.15‡ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Gulf ports | 2.45*a* | 2.40*a* | .... | .... | 2.85*a* | .... | .... | .... | .... | .... | .... | .... |
| Pacific ports | 2.70*a* | 2.50*a* | .... | .... | 2.90*a* | .... | .... | .... | .... | 3.00 | 2.25 | .... |

‡ Delivered. *a* F.o.b. cars dock. *b* For rail steel deduct 15c. from billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

## IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

| | STRUCTURAL SHAPES Per 100 lb., base price | REINFORCING BARS Per 100 lb., ¼ in., base price 15 tons or over *b* New billet | Rail steel | Add Switch | $/cwt. for Del. | EXPANDED METAL LATH—Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb. | Std. ribbed 3.4 lb. | WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires | 4x12 in., No. 8 & 12 wires | 6x6 in. No. 6 & 6 wires Per sq. yd. | SHEET PILING Per 100 lb. base price |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $2.74 | $2.29 | $2.14 | .02½ | .10 | $21.00 | $23.00 | 1.66 | $1.25 | $0.1566 | $3.04 |
| Baltimore | 3.55 | 2.70 | 2.55 | ..... | .10 | 21.00 | 23.00 | 1.54 | 1.17 | .1458 | 2.70 |
| Birmingham | 2.10*a* | 2.05 | 1.90 | .02½ | .10 | 19.50 | 21.50 | 1.64 | 1.23 | .1548 | .... |
| Boston | 3.85 | 2.58 | 2.43 | $20 C.L. | .10 | 21.50‡ | 23.50‡ | 1.60 | 1.21 | .1512 | 2.99 |
| Chicago | 2.10*a* | 2.05 | 1.90 | .03 | .05 | 18.50 | 20.50 | 1.51 | 1.15 | .1422 | 2.40 |
| Cincinnati | 3.88 | 2.31*c* | 2.16*c* | ..... | .05 | 20.50 | 22.50 | 1.50 | 1.14 | .1413 | .... |
| Cleveland | 3.43*g* | 2.05 | 1.90 | .02½ | .10 | 20.50 | 22.50 | 1.50 | 1.14 | .1422 | .... |
| Dallas | 4.15 | 2.80 | 2.65 | ..... | ..... | 25.00 | 27.00 | 1.77 | 1.32 | .1674 | .... |
| Denver | 4.21 | 3.89 | 3.74 | ..... | ..... | 23.50 | 25.50 | 1.81 | 1.34 | .1710 | .... |
| Detroit | 3.80‡ | 2.55 | 2.40 | ..... | .10 | 22.50 | 24.50 | 1.52 | 1.16 | .1440 | 2.875 |
| Kansas City | 4.10 | 2.51*c* | 2.36*c* | .0 | .05 | 18.50 | 20.50 | 1.62 | 1.22 | .1539 | 2.86 |
| Los Angeles | 3.50*f* | 2.65 | 2.50 | .02½ | .05 | 23.00 | 27.50 | 1.77 | 1.32 | .1674 | 3.50 |
| Minneapolis | 3.80‡ | 2.38*c* | 2.23*c* | .0 | .10 | 21.50 | 24.50 | 1.64 | 1.23 | .1548 | 2.73*d* |
| Montreal | 3.25 | 2.65 | 2.55 | ..... | ..... | 26.68 | 29.90 | 2.99 | 2.08 | .314 | 3.95 |
| New Orleans | 3.90 | 2.69 | 2.54 | .05 | .10 | 21.00 | 23.00 | 1.67 | 1.26 | .1584 | 2.875 |
| New York | 3.75 | 2.29 | 2.14 | ..... | .10 | 20.50 | 22.50 | 1.56 | 1.19 | .1476 | 2.76 |
| Philadelphia | 3.40 | 2.37 | 2.22 | ..... | ..... | 20.50 | 22.50 | 1.55 | 1.18 | .1467 | 2.72 |
| Pittsburgh | 2.10*a* | 2.05 | 1.90 | .02½ | .10 | 21.50 | 24.50 | 1.43 | 1.10 | .1350 | 2.40 |
| St. Louis | 3.82 | 2.29 | 2.14 | .0 | .05 | 23.50 | 25.50 | 1.53 | 1.16 | .1449 | 2.70 |
| San Francisco | 3.90 | 2.50 | 2.35 | .02½ | .10 | 23.50 | 25.50 | 1.77 | 1.32 | .1674 | 3.00 |
| Seattle | 2.70*e* | 2.65*e* | ..... | ..... | ..... | 25.50 | 27.50 | 1.77 | 1.32 | .1674 | 2.90*e* |

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c.

## PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

| | C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a* | VITRIFIED SEWER PIPE Per foot, 8 in., s.s. | delivered 12 in., s.s. | ASTM 24-in., d.s. | C13–35 36 in., d.s. | CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in. | f.o.b. 8 in. | CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in. | C 14–35 24 in. | WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black % | Galv. % | 3½ to 6 in., Lap Weld Black % | Galv. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $46.40 | $0.26*bc* | $0.468*bc* | $1.69 | $4.50*c* | $85.00 | $128.00 | $0.45 | $1.625 | 62.2 | 54.2 | 59.7 | 51.2 |
| Baltimore | 49.80 | .30 | .55 | 2.40 | 6.25 | 110.00 | 170.00 | .50 | 1.75 | 65.5 | 57.5 | 63.0 | 54.5 |
| Birmingham | 42.00 | .25 | .45 | 1.625 | 4.66 | 85.00 | 220.00 | .40 | 1.60 | 62.2 | 54.2 | 59.7 | 51.2 |
| Boston | 52.00 | .28 | .54 | 2.2475 | 6.67 | 136.00‡ | 196.50‡ | .50 | 2.50 | 64.1 | 56.1 | 61.6 | 53.1 |
| Chicago | 50.80 | .28 | .54 | 2.25 | 6.25 | 100.00‡ | 150.00‡ | .38 | 1.48 | 67.0 | 59.0 | 63.5 | 55.0 |
| Cincinnati | 49.70 | .231 | .4455 | 1.755 | 5.2275 | 75.00 | 120.00 | .60 | 1.90 | 65.9 | 57.9 | 63.4 | 54.9 |
| Cleveland | 51.24 | .21 | .405 | 1.575 | 4.8175 | 69.00 | 108.00 | .34 | 1.45 | 67.8 | 59.8 | 65.3 | 56.8 |
| Dallas | 55.20 | .27 | .486 | 1.944 | 4.70 | 80.00 | 100.00 | .46 | 1.57 | 59.9 | 51.9 | 57.3 | 48.3 |
| Denver | 57.60 | .29† | .50† | 2.10† | ..... | 130.00 | 220.00 | ..... | ..... | 58.4 | 50.4 | 55.7 | 47.2 |
| Detroit | 51.24 | .147 | .2835 | 1.215 | 4.70 | 66.45 | 111.40 | .25 | 1.125 | 66.3 | 58.3 | 63.8 | 55.3 |
| Kansas City | 52.12 | .30 | .54 | 2.16 | 5.00 | 120.00 | 240.00 | .45 | 1.60 | 62.9 | 54.9 | 60.0 | 51.5 |
| Los Angeles | 52.00 | .282† | .508† | 2.034† | 5.085† | 115.50 | 192.50 | 1.00 | 2.00 | 56.8 | 47.8 | 54.3 | 44.8 |
| Minneapolis | 54.20 | .24† | .432† | 1.728† | 4.60† | ..... | ..... | .70 | 1.80 | 64.2 | 56.2 | 60.7 | 52.2 |
| Montreal | 60.00 | .59 | .90 | 3.15 | 5.10*e* | 135.00‡ | 260.00‡ | .48 | 1.92 | ..... | ..... | ..... | ..... |
| New Orleans | 48.38 | .26 | .48 | 1.69 | ..... | 150.00 | 220.00 | .37 | 2.10 | 62.4 | 54.4 | 58.8 | 50.3 |
| New York | 49.20 | .32 | .63 | 2.35 | 6.15 | ..... | ..... | .50 | 1.20 | 64.9 | 56.8 | 62.4 | 53.9 |
| Philadelphia | 47.90 | .21 | .405 | 1.75 | 5.05 | 100.00 | 160.00 | .54 | 1.80 | 65.3 | 57.3 | 62.8 | 54.3 |
| Pittsburgh | 52.60 | .182† | .351† | 1.44† | 4.20 | 97.80 | 154.20 | .85*g* | 2.00*g* | 68.5*i* | 60.5*i* | 66.0*i* | 57.5*i* |
| St. Louis | 49.48 | .265 | .468 | 2.016 | 3.96 | 85.00 | 170.00 | .80 | 2.00 | 65.1 | 57.1 | 62.0 | 53.5 |
| San Francisco | 52.00 | .3275*d* | .5895*d* | 2.358 | 5.895 | 107.25 | 178.75 | .45 | 2.50 | ..... | ..... | ..... | ..... |
| Seattle | 52.35 | .35 | .63 | 2.52 | 6.30 | 72.00 | 175.00 | .50*f* | 1.40*f* | ..... | ..... | ..... | ..... |

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ⅛ in., 8½c.; ¼ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20.

(Continued on page 80)

# Everything
## *for Oxy-Acetylene Welding and Cutting*

PROGRESS in the art of working metals requires a convenient and dependable source of acetylene, calcium carbide, oxygen, and welding and cutting apparatus and supplies. Whether you use the oxy-acetylene process for welding, cutting, flame-hardening, hard-facing, flame-softening, or steel conditioning, you can obtain promptly all the necessary products and service through The Linde Air Products Company.

*Gases*—Linde Oxygen is sold throughout the nation in gray-and-green cylinders. Each cylinder contains 110 cubic feet or 220 cubic feet of oxygen at a pressure of 2,000 pounds per square inch. All Linde Oxygen—whether for industrial or therapeutic use—is the same high and uniform quality.

Prest-O-Lite Dissolved Acetylene is produced from Union Carbide. For welding and cutting, it is sold in portable black steel cylinders having rated capacities of 100 cubic feet and 300 cubic feet of acetylene. For use with Prest-O-Lite appliances—heating torches, soldering irons and portable lights—Prest-O-Lite Dissolved Acetylene is sold in small steel tanks of 10- and 40-cubic feet capacity.

*Calcium Carbide*—Union Carbide is packed in 100-pound lots in blue-and-gray drums. Because of its uniform quality, high gas yield, accurate sizing, and careful packing, it has been recognized as a standard of excellence for over forty years. Union Carbide, an electric furnace product, is crushed and screened to all standard generator sizes.

Carbic Processed Carbide is high-grade calcium carbide, specially treated and compressed into cakes for use in Carbic acetylene generators and Carbic acetylene flood lights. The most frequently used size of Carbic cakes is No. 20. The orange drum contains 40 cakes weighing 100 pounds.

Union Carbide and Carbic Processed Carbide are readily available from warehouses, jobbers, and distributors throughout the country.

*Apparatus*—Oxweld, Prest-O-Weld, and Purox lines of welding and cutting blowpipes, regulators, manifolds, and outfits; Oxweld cutting machines; Oxweld and Carbic acetylene generators; and the complete Oxweld line of accessories, welding rod, and supplies—all are sold by Linde.

*Service*—The Linde service organization brings to users of the oxy-acetylene process practical field experience, based on comprehensive research and development facilities. This process service is available from field engineers—also through technical books, booklets, magazine articles, motion pictures, and in numerous other ways.

The words "Linde," "Union," "Prest-O-Lite," "Prest-O-Weld," "Purox," "Oxweld" and "Carbic" are trade-marks of Units of Union Carbide and Carbon Corporation.

## The Linde Air Products Company

*Unit of Union Carbide and Carbon Corporation*

UCC

New York and Principal Cities · In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN · PREST-O-LITE ACETYLENE · OXWELD APPARATUS AND SUPPLIES · UNION CARBIDE

(Continued from page 78)

## LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

| | SHORT LEAF YELLOW PINE AND DOUGLAS FIR | | | | | | | | | LONG LEAF Y. P. | | PLYWOOD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) | | | | | | | | | Merchantable grade up to 20 ft. | | Rail freight increment (See note for base price) | |
| | *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)* | | | | | | | | | | | | |
| | 1x6, S4S | 1x8, S4S | 2x4, S4S | 2x6, S4S | 2x8, S4S | 2x10, S4S | 3x12, Rgh | 6x12, Rgh | 12x12, Rgh | 2x12, Rgh | 12x12, Rgh | 5/8" | 3/4" |
| Atlanta | $19.50 | $19.50 | $19.50 | $20.00 | $20.00 | $20.00 | $27.00 | ..... | ..... | $38.50 | $50.50 | $17.75 | $21.60 |
| Baltimore | 24.00 | 25.00 | 24.00 | 25.00 | 26.00 | 27.00 | 39.00 | ..... | ..... | 66.00 | 70.00 | 17.35*g* | 21.15*g* |
| | *31.00* | *31.00* | *31.00* | *31.00* | *31.00* | *31.00* | *39.00* | *$39.00* | *$39.00* | ..... | ..... | ..... | ..... |
| Birmingham | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 20.00 | 30.00 | 30.00 | 30.00 | ..... | ..... | 16.25 | 19.85 |
| [1] | 22.00 | 22.00 | 26.00 | 26.00 | 26.00 | 36.00 | 54.00 | ..... | ..... | 48.00 | 53.00 | ..... | ..... |
| Boston | 28.00[2] | 28.00[2] | 30.00[2] | 30.00 | 48.00[1] | 60.00[1] | 72.00[1] | ..... | ..... | 72.00 | 72.00 | 17.35*g* | 21.15*g* |
| | *26.00* | *26.00* | *28.00* | *28.00* | *32.00* | *32.00* | *35.00* | *40.00* | *40.00* | ..... | ..... | ..... | ..... |
| Chicago | 29.00 | 30.00 | 32.00 | 32.00 | 32.00 | 32.00 | 47.00 | ..... | ..... | 75.00 | 85.00 | 13.15 | 16.05 |
| | *33.00* | *34.00* | *36.00* | *36.00* | *36.00* | *36.00* | *41.00* | *40.00* | *40.00* | ..... | ..... | ..... | ..... |
| Cincinnati | 23.75 | 23.75 | 25.00 | 23.50 | 24.50 | 26.50 | 37.50 | ..... | ..... | 46.00 | 49.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | ..... | ..... | ..... | *39.50* | *39.50* | *39.50* | ..... | ..... | ..... | ..... |
| Cleveland *f* | 30.00 | 31.00 | 36.00 | 31.00 | 32.00 | 40.00 | 48.00 | ..... | ..... | 52.00 | 62.00[3] | 16.65 | 20.25 |
| Dallas *e* | 28.50 | 31.50 | 30.00 | 26.00 | 28.50 | 31.50 | 55.00 | 54.00 | 54.00 | 64.50 | 71.00 | 13.90 | 16.95 |
| Denver ‡ | 41.00[4] | 39.00[4] | 43.00[4] | 42.00[4] | 42.00[4] | 47.00[4] | 45.00[4] | 56.00[4] | 64.50[4] | ..... | ..... | 9.90 | 12.05 |
| Detroit | 24.00 | 24.00 | 25.00 | 25.00 | 26.00 | 26.00 | 34.00 | ..... | ..... | 33.00 | 43.00 | 16.25 | 19.85 |
| | ..... | ..... | ..... | *36.00* | *36.00* | *35.00* | *37.00* | *40.00* | *40.00* | ..... | ..... | ..... | ..... |
| Kansas City | 27.00 | 28.50 | 28.00 | 26.00 | 28.00 | 30.00 | 35.00 | ..... | ..... | 55.00 | 58.00 | 12.25 | 14.95 |
| | *28.00* | *28.00* | *28.00* | *28.00* | *28.00* | *29.00* | *34.00* | *35.00* | *35.00* | ..... | ..... | ..... | ..... |
| Los Angeles *a* | *35.00* | *35.00* | *35.00* | *35.00* | *36.00* | *36.00* | *42.00* | *46.00* | *42.00* | ..... | ..... | 9.35*gh* | 11.35*gh* |
| Minneapolis [5]*b* | 43.00[5] | 43.00[4] | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 12.05 | 14.70 |
| ‡ | *34.00* | *34.00* | *35.00* | *35.00* | *35.00* | *35.00* | *55.00* | *55.00* | *55.00* | ..... | ..... | ..... | ..... |
| Montreal [7] | *45.00* | *45.00* | *49.00* | *47.00* | 48.00 | 58.00 | 84.00 | ..... | ..... | 135.00 | 145.00 | ..... | ..... |
| | *40.00* | *40.00* | *40.00* | *40.00* | *40.00* | *41.50* | *42.00* | *41.00* | *40.00* | ..... | ..... | ..... | ..... |
| New Orleans | 22.00 | 22.00 | 20.00 | 19.00 | 20.00 | 22.00 | 42.00 | ..... | ..... | 58.00 | 65.00 | 13.90 | 16.95 |
| | *26.00* | *26.00* | *28.00* | *29.00* | *32.00* | *30.00* | *52.00* | ..... | ..... | ..... | ..... | ..... | ..... |
| New York ‡ | 36.00 | 37.00 | 35.00 | 36.00 | 36.00 | 37.00 | 42.00 | ..... | ..... | 77.50 | 80.00 | 17.35*g* | 21.15*g* |
| ‡ | ..... | ..... | *40.00* | *40.00* | *40.00* | *40.00* | *40.00* | *42.50* | *42.50* | ..... | ..... | ..... | ..... |
| Philadelphia | 23.50 | 24.00 | 25.00 | 25.00 | 26.00 | 26.50 | 28.50 | ..... | ..... | 54.00 | 56.00 | 17.35*g* | 21.15*g* |
| | *54.00* | *55.50* | *58.00* | *57.25* | *56.50* | *56.50* | *41.75* | *31.50* | *31.50* | ..... | ..... | ..... | ..... |
| Pittsburgh | 38.10 | 39.90 | 47.05 | 42.00 | 45.65 | 46.90 | 59.70 | ..... | ..... | ..... | ..... | 17.00 | 20.70 |
| | *51.90* | *49.60* | *49.60* | *49.00* | *48.90* | *49.25* | *66.55* | *66.55* | *66.55* | ..... | ..... | ..... | ..... |
| St. Louis ‡*c* | 31.00 | 32.50 | 31.00 | 29.50 | 30.50 | 32.00 | 48.00 | *51.00* | *51.00* | 74.00 | 73.00 | 13.90 | 16.95 |
| San Francisco *d* | *19.00* | *19.00* | *19.00* | *19.00* | *19.00* | *19.00* | *23.00* | *23.00* | *23.00* | ..... | ..... | 7.30*g* | 8.90*g* |
| Seattle | *20.00* | *20.00* | *20.00* | *20.00* | *20.00* | *20.00* | *26.00* | *26.00* | *26.00* | ..... | ..... | 0.00 | 0.00 |

**Bold Face type, Southern Pine.** *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price — Seattle: 1/2", $73.50 net. 3/4", $81.50 net. For other centers add rail freight increment from table for proper size. Form oil treatment, and mineral paint sealed edge, charges included. For resin dipped treatment, $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

## GLASS, EXPLOSIVES, CHEMICALS

| | WINDOW GLASS Discounts from latest jobbers list, Sept. 15, 1928 Single or Double Thickness | | EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots* |
|---|---|---|---|
| | A quality | B quality | |
| Atlanta | 78%*d* | 78%*d* | $0.15 |
| Baltimore | 88% | 87% | .16 |
| Birmingham | 89% | 90% | .115 |
| Boston | 87% | 89% | .16 |
| Chicago | 79%*c* | 79%*c* | .16 |
| Cincinnati | 79–10%*d* | 79–10%*d* | .16 |
| Cleveland | 85–10% | 85–10% | .20 |
| Dallas | 80% | 80% | .175 |
| Denver | 76%*d* | 76%*d* | .16*e* |
| Detroit | 87–10% | 89–10% | .16 |
| Kansas City | 78–10% | 79–10% | .165 |
| Los Angeles | 90%*a* | 90@40% | .1675 |
| Minneapolis | 76%*d* | 76%*d* | .165 |
| Montreal | 70–10%*b* | | .18† |
| New Orleans | 86% | 88% | .17 |
| New York | 82%*d* | 83%*d* | .23 |
| Philadelphia | 89–10% | 90–10% | .16 |
| Pittsburgh | 86% | 87% | .1525 |
| St. Louis | 86–10% | 87–10% | .165 |
| San Francisco | 78% | 83% | .165 |
| Seattle | 86% | 90% | .1675 |

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

*a* Disc. from list Aug. 1, 1929. *b* Also less 6% tax exemption. *c* Discounts from jobbers list, Nov. 16, 1938. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

**40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)**

| | C/L 20,000 lb. net | Tons | 200 lb. lots |
|---|---|---|---|
| E. of the Miss., except Fla. | $0.115 | $0.14 | $0.16 |
| W. of Miss., to Rocky Mtn. States, and Fla. | .12 –.13 | .145 –.16 | .165 –.18 |
| Rocky Mtn. States | .12 –.1425 | .14 –.155** | .16 –.175** |
| Pacific N. W. States | .1175–.13 | .1475–.16 | .1675–.18 |
| Pacific S. W. States | .1150–.1275 | .145 –.1525 | .165 –.1725 |

** F.o.b. Louviers, Colo., or Butte, Mont.

## PILES, TIES—F.O.B.

**PILES**

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

| Dimensions | Points | Length | Short Leaf Barge | Short Leaf Rail |
|---|---|---|---|---|
| 12 in. at butt | 6 in. | 30 to 50 ft. | $0.18 | $0.195 |
| 12 in.— 2 ft. from butt | 6 in. | 50 to 59 ft. | .225 | .24 |
| 12 in.— 2 ft. from butt | 6 in. | 60 to 69 ft. | .23 | .255 |
| 14 in.— 2 ft. from butt | 6 in. | 50 to 69 ft. | .24 | .265 |
| 14 in.— 2 ft. from butt | 6 in. | 70 to 79 ft. | .28 | .275 |
| 14 in.— 2 ft. from butt | 5 in. | 80 to 85 ft. | .40 | .415 |
| 14 in.— 2 ft. from butt | 5 in. | 85 to 89 ft. | .42 | .482 |

**RAILWAY TIES**

| Prices f.o.b., per tie for carload lots: | | 6" x8" x8' Untr. | 6" x8" x8' Tr. | 7" x 9" x8'6" Untr. | 7" x 9" x8'6" Tr. |
|---|---|---|---|---|---|
| Boston | Oak | $1.10 | .... | $1.60 | .... |
| | Pine | 1.25 | $1.90*a* | 1.85 | $2.75*a* |
| New York | S. L. Sap Pine | 1.05/1.15 | 1.90*g* | .... | 2.35*g* |
| | Mixed Oak | 1.50 | 1.35 | 1.85 | .... |
| Birmingham | White Oak | .85 | 1.50*a* | 1.35 | 1.70*a* |
| | Southern Pine | .55*b* | 1.10*ab* | .70 | 1.30*a* |
| Chicago | Oak | .... | 1.65*a* | .... | 2.25*a* |
| | Southern Pine | .... | 1.53*a* | .... | 2.13*a* |
| Los Angeles | Douglas Fir | .64 | 1.38*a* | .90 | 1.80*a* |
| Philadelphia | Red Oak | 1.10 | .... | .... | 2.40*a* |
| St. Louis | White Oak | .90 | .... | 1.25 | .... |
| | Red Oak | .90 | 1.40*a* | 1.25 | 1.85*a* |
| | Sap Pine or Cypress | .80 | .... | 1.15 | .... |
| San Francisco | Douglas Fir | .80*bef* | .... | .... | 1.85*caf* |
| Montreal | Birch or Maple | .65 | 1.05*a* | .75 | 1.35*a* |

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle. *g* Dense pine.

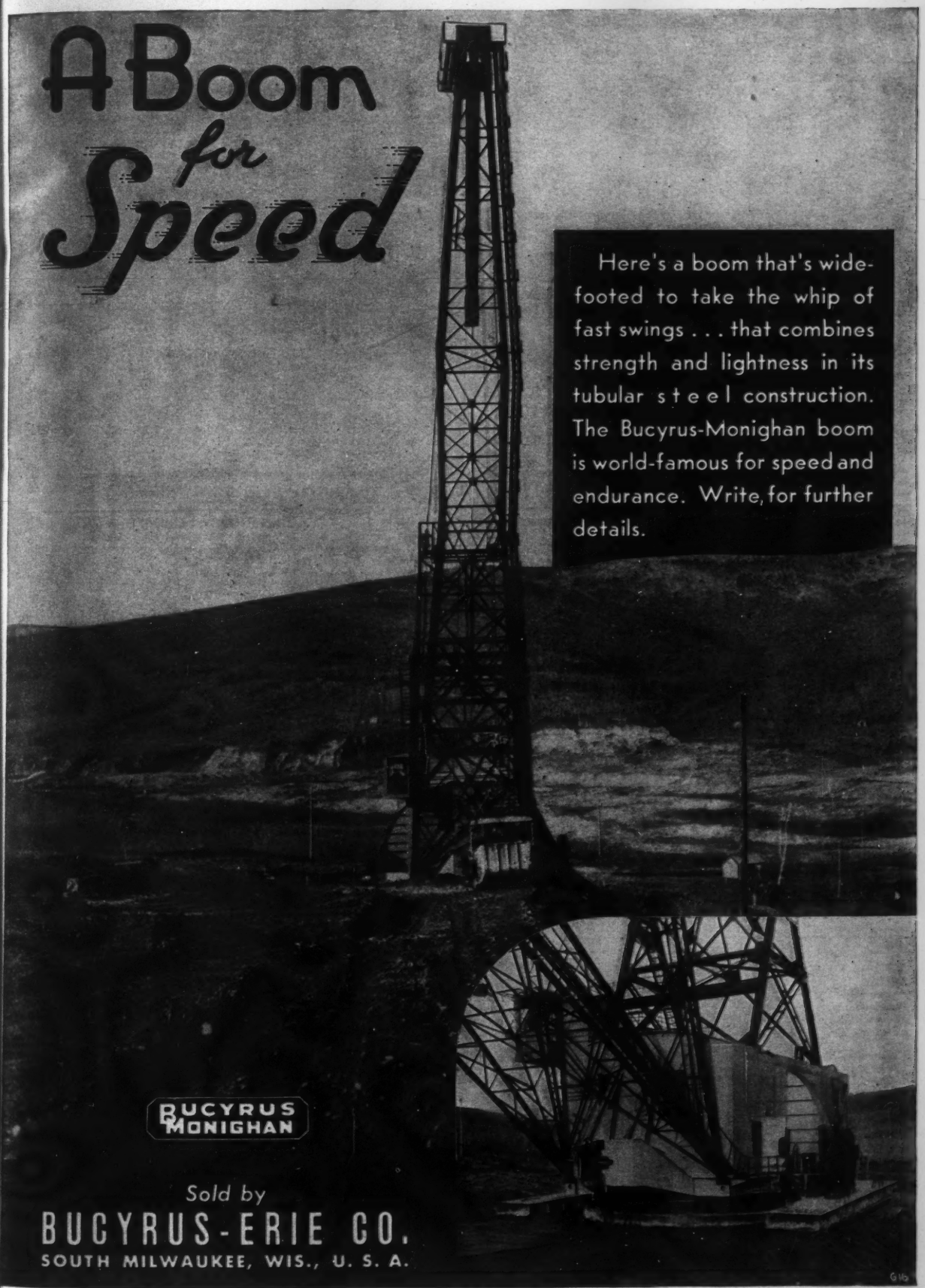
**CHEMICALS**

**Water, sewage treatment, road work, f.o.b. carlots, New York**

| | |
|---|---|
| Bleaching powder, in drums, f.o.b. works, per 100-lb. | $2.00–2.85 |
| Chlorine cylinders, per lb. delivered | .055 |
| Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton | 22.00–35.00 |
| Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb. | 1.40 |
| Soda ash, 58%, in paper bags, per 100 lb. dense | 1.10 |
| Sulphate of aluminum, commercial, in 100-lb. bags, per ton | 23.00 |
| Sulphate of copper, in bbl., per 100-lb. | 4.50 |

(Continued on page 82)

# A Boom for Speed



Here's a boom that's wide-footed to take the whip of fast swings . . . that combines strength and lightness in its tubular steel construction. The Bucyrus-Monighan boom is world-famous for speed and endurance. Write, for further details.

BUCYRUS MONIGHAN

Sold by

BUCYRUS-ERIE CO.

SOUTH MILWAUKEE, WIS., U. S. A.

(Continued from page 80)

## STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

| | STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in. | 4x12x12 in. | 8x12x12 in. | STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in. | 10x12x12 in. | 12x12x12 in. | BRICK Per M. in quantity. Common backing | Straight hard | LIME Per ton, Hydrated finishing | In paper Common hydrated | Carload lots Pulverized or lump |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $100.00 | $120.00 | $200.00 | $230.00 | $240.00 | $250.00 | $12.50 | $16.00 | $24.00 | $15.50 | $15.50 |
| Baltimore | 74.00 | 80.00 | 165.00 | 195.00 | 250.00 | 300.00 | 13.00*k* | 16.00*k* | 14.00 | 15.00 | 22.00 |
| Birmingham | 78.75 | 84.00 | 157.50 | 189.00 | 201.25 | 242.00 | 15.00 | 19.00 | 3.00*o* | 1.75*o* | 2.25*o* |
| Boston | 90.75*ab* | 96.80*ab* | 181.50*ab* | 205.70*ab* | 266.70*ab* | 304.80*a* | 17.00*i* | 20.00*i* | 19.00 | 13.00 | 3.10*p* |
| Chicago | 68.10 | 72.60 | 135.90 | 185.70 | 234.90 | 268.10 | 11.00 | 12.00 | 16.40 | 14.40 | 12.20 |
| Cincinnati | 61.40 | 65.30 | 121.90 | 141.50 | 187.30 | 215.20 | 16.00 | 16.00 | 15.90 | 13.00 | ..... |
| Cleveland | 52.50 | 56.00 | 105.00 | 126.00 | 170.00 | 194.50 | 15.50 | 15.50 | 15.20*j* | 12.80*j* | 2.65*jm* |
| Dallas | 62.50 | 67.00 | 135.00 | 162.00 | 177.00 | 263.00 | 11.50*i* | 13.50*i* | 19.00 | 15.00 | .95*n* |
| Denver | 78.50 | 88.00 | 141.50 | 166.50 | 196.00 | 225.50 | 12.00 | 15.50 | 28.00*j* | 17.00*j* | 35.00*j* |
| Detroit | 68.90 | 73.50 | 137.80 | 175.50 | 232.00 | 265.00*e* | 16.00 | 17.00 | 13.50 | 11.25 | 12.75 |
| Kansas City | 64.50 | 66.50 | 86.00*c* | 125.50 | 159.75 | 186.25 | 14.00 | 24.00 | 19.10 | 12.80 | 10.70 |
| Los Angeles | 73.50†*r* | 89.50†*r* | 128.00*c*†*r* | 210.00†*r* | 368.00†*r* | 460.00†*r* | 12.00 | 14.00 | 16.50 | ..... | 17.50 |
| Minneapolis | 80.35 | 85.70 | 146.00 | 192.85 | 176.20*d* | 245.20*d* | 13.10 | 15.10*g* | 21.00 | 16.00 | 19.00 |
| Montreal | 64.00*a* | 77.00*a* | 141.00*a* | 77.00*a* | 128.00*a* | ..... | 21.00 | 31.00 | 24.60 | 16.00 | 1.75*o* |
| New Orleans | 72.00 | 72.00 | 135.00 | 162.00 | 210.00 | 260.00 | 14.00 | ..... | 18.30 | 12.08 | 14.10 |
| New York | 87.00 | 93.00 | 128.00 | 193.30*h* | 238.80*h* | 295.60*h* | 13.50 | ..... | 20.00 | 15.00 | 18.00 |
| Philadelphia | 77.40 | 82.50 | 154.50 | 185.70 | 229.90 | 284.60 | 11.00*s* | 18.00*s* | 15.50*q* | 10.05 | 10.55 |
| Pittsburgh | 58.40 | 62.40 | 116.85 | 124.00 | 153.00 | 193.75 | 17.00 | 25.00 | 17.70 | 15.20 | 2.57*m* |
| St. Louis | 62.00 | 65.00 | 120.00 | 180.00 | 234.00 | 280.00 | 16.00 | 17.00 | 22.00 | 16.00 | 2.30*m* |
| San Francisco | 84.00 | 94.50 | 225.00 | ..... | ..... | ..... | 14.00 | 17.00 | .55*o* | .40*o* | 2.05*m* |
| Seattle | 100.00 | 110.00 | 220.00 | ..... | ..... | ..... | 17.50*f* | 17.50*f* | 20.00*s* | 20.00*s* | 20.00*s* |

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

## PAINT, ROOFING—F.O.B. CARLOAD LOTS

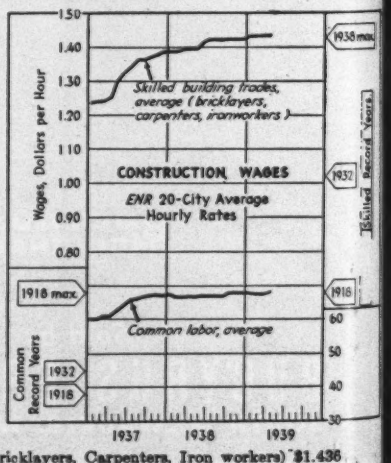
| | RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry | WHITE LEAD Per 100 lb. in oil | READY-MIXED PAINT Per gal., drums Graphite *b* | Aluminum *c* | Ferric Oxide *d* | ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq. | Asphalt felt, per 100 lb. | Tar felt, per 100 lb. | Asphalt coating per gal. | Tar pitch 350 lb. bbl. per ton |
|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | $8.50 | $12.625 | $1.30 | $2.25 | $1.20 | $1.71 | $1.65 | $1.65 | $0.36 | $26.00 |
| Baltimore | 8.25 | 12.25 | 1.45 | 2.25 | 1.70 | 2.16 | 2.75 | 2.75 | .40 | 27.50 |
| Birmingham | 8.50 | 12.625 | 2.35 | 2.35 | 1.85 | 2.07 | 2.03 | 2.03 | .45 | 30.37 |
| Boston | 8.25 | 12.25 | 1.80‡ | 2.20‡ | 1.80‡ | 1.70‡ | 1.85*h*‡ | 1.85*h*‡ | .38‡ | 20.00‡ |
| Chicago | 8.25 | 12.25 | 1.88 | 2.53 | 1.56 | 1.65*hf* | 1.49*hf* | 1.49*hf* | .26*f* | 21.00*f* |
| Cincinnati | 8.25 | 12.25 | 1.45 | 2.50 | 1.40 | 2.40 | 2.39*h* | 2.39*h* | .36 | 21.00 |
| Cleveland | 8.25 | 12.25 | 1.90 | 2.60 | 1.40 | 1.45 | 1.50*h* | 1.50*h* | .35 | 21.00 |
| Dallas | 8.25 | 13.00 | 1.80 | 1.95 | .... | 2.75*h* | 2.50*h* | 2.50*h* | .60 | .... |
| Denver | 8.75 | 12.75 | .... | .... | .... | 2.45 | 4.00 | 3.00 | .35 | 28.00 |
| Detroit | 8.25 | 12.25 | 2.00 | 3.00 | 1.75 | 2.40 | 3.00 | 3.00 | .35 | 29.00 |
| Kansas City | 8.25 | 12.375 | 2.15*g* | 2.40*g* | 1.67*g* | 1.93 | 2.09 | 2.09 | .25 | 25.00 |
| Los Angeles | 8.50 | 12.75 | 1.60 | 2.25 | 2.30 | 2.10 | 1.50 | .... | .45 | .... |
| Minneapolis | 8.25 | 12.375 | .... | .... | .... | 1.45*i* | 1.50*hi* | 1.50*hi* | .29 | 21.00 |
| Montreal | 9.75 | 9.00 | 2.25 | 2.80 | 2.35 | 3.05 | 1.85 | 2.15 | .95 | 10.80*k* |
| New York | 8.25 | 12.25 | 1.80 | 2.45 | 1.48 | 1.45 | 1.50*h* | 1.50*h* | .23 | 24.00 |
| Philadelphia | 8.25 | 12.25 | .... | .... | .... | 1.92*e* | 1.99*he* | 1.99*he* | .41*e* | 21.00 |
| Pittsburgh | 8.25 | 12.25 | 1.05 | 1.95 | .80 | 1.95 | 1.94*h* | 1.94*h* | .34 | 26.00 |
| St. Louis | 8.25 | 12.25 | 1.70/1.90 | 2.50/2.75 | 1.50/1.90 | 1.45 | 1.50 | 1.50 | .22 | 21.00 |
| San Francisco | 8.50 | 12.50 | 1.80 | 2.75 | 1.10/2.00 | 1.66 | 1.90 | 1.90 | .325 | 20.50 |
| Seattle | 8.50 | 12.75 | 1.80 | 3.00 | 2.20 | 2.02 | 1.43/2.10 | 2.60 | .54 | 24.10*j* |

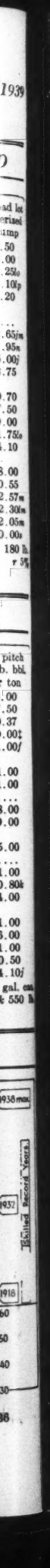
‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* 550 lb. barrel.

## SKILLED AND COMMON WAGE RATES—PER HOUR

| | Bricklayers | Carpenters | Struct. Iron Workers | Hoisting Engineers | Plasterers | Common Labor Building | Common Labor Heavy Const. |
|---|---|---|---|---|---|---|---|
| Atlanta | $1.25 | $1.00 | $1.25 | $1.00/1.25 | $1.25 | $0.40/.50 | $0.40/.50 |
| Baltimore | 1.50 | 1.25 | 1.50 | 1.50 | 1.25 | .5625 | .5625 |
| Birmingham | 1.50 | 1.125 | 1.25 | 1.125 | 1.00 | .30/.40*a* | .30/.40*a* |
| Boston | 1.50 | 1.375 | 1.50 | 1.375 | 1.625 | .60/.85 | .60/.85 |
| Chicago | 1.70 | 1.625 | 1.70 | 1.625 | 1.70 | 1.025 | 1.025 |
| Cincinnati | 1.00/1.625 | 1.45 | 1.525 | 1.525 | 1.625 | .60/.75 | .60/.75 |
| Cleveland | 1.625 | 1.375 | 1.50 | 1.50 | 1.50 | .90 | .90 |
| Dallas | 1.50 | 1.25 | 1.25 | 1.00 | 1.50 | .40 | .40 |
| Denver | 1.50*b* | 1.50*b* | 1.43*b* | .... | 1.43*b* | .718*b* | .718*b* |
| Detroit | 1.50 | 1.25 | 1.50 | 1.50 | 1.55 | .60/.80 | .60/.80 |
| Kansas City | 1.625 | 1.375 | 1.50 | 1.50 | 1.575 | .85 | .45/.50 |
| Los Angeles | 1.25 | 1.10 | 1.375 | 1.375 | 1.50 | .625 | .625 |
| Minneapolis | 1.375 | 1.25*d* | 1.50 | 1.40 | 1.50*e* | .85 | .85 |
| New Orleans | 1.00 | 1.00 | 1.25 | 1.00 | 1.00 | .40 | .40 |
| New York | 1.886*b* | 1.75*b* | 1.925 | 2.00*b* | 2.00*c* | 1.031 | .875/.95 |
| Philadelphia | 1.65 | 1.25 | 1.50 | 1.50 | 1.565 | .60 | .60 |
| Pittsburgh | 1.75 | 1.50 | 1.50 | 1.25 | 1.75 | .80 | .70 |
| St. Louis | 1.50 | 1.25 | 1.75 | 1.57/2.00 | 1.58 | .45/.875 | .45/.875 |
| San Francisco | 1.75*c* | 1.25*f* | 1.50 | 1.50 | 1.60*c* | .81 | .65 |
| Seattle | 1.60*c* | 1.25*c* | 1.50*c* | 1.50*c* | 1.60*c* | .90*c* | .90*c* |
| Montreal | .70 | .60 | .60 | .55 | .67 | .35 | .40 |

*a* PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.




**ENR Skilled Average:** (Bricklayers, Carpenters, Iron workers) $1.436

**ENR Common Average:** $0.683